University of Nevada, Reno

The Ecology of Signal Crayfish in Two Large Ultra-Oligotrophic Ecosystems: Crater Lake and Lake Tahoe

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Abstract

Invasive species have become an increasing problem in the Western United States particularly when there are multiple stressors (e.g., invasive species and eutrophication) occurring to ecosystems. Invasive omnivores can present unique problems for aquatic ecosystems by having both direct and indirect impacts on native benthic invertebrates and vertebrates. Omnivorous crayfish, for example, strongly influence littoral habitats and biota with their foraging habits, creating both direct and indirect effects on trophic interactions in aquatic systems. Once they invade, these crayfish can ultimately dominate freshwater ecosystems. This dissertation investigates the distribution, density changes, and the direct and indirect impacts of the invasive signal crayfish (*Pacifastacus leniusculus*) in two oligotrophic lentic ecosystems in the western United States; Lake Tahoe (CA-NV) and Crater Lake (OR).

In chapter 1, I investigate the distribution, movement, and feeding behavior of invasive signal crayfish in Crater Lake. This lake population presents a unique opportunity to understand the movement of crayfish in a recently expanding population. I used minnow traps and snorkeling to determine crayfish distribution and stable isotope ratios of δ^{13}C and δ^{15}N to determine the flow of organic matter through the food web, trophic position, and percent benthic reliance. Depth gradient minnow traps demonstrate that crayfish densities can live as deep as 250 m. Trap and snorkel surveys from 2008 to 2013 indicate an expansion of crayfish from 44% to 78% of the littoral zone. Summer water temperature in Crater Lake has been warming, which may increase the recruitment of individuals and expand habitat availability for growth. Between 1965 and 2014 the nearshore surface temperature increased by 3.5°C. Principal component analysis revealed a positive relationship between crayfish occupation and cobble and boulder habitats of the lake. Crayfish in the littoral zone rely heavily (97.4%) on littoral-benthic carbon sources indicating their potential for impacting native invertebrate communities and the overall dynamics of Crater Lake's ecosystem. Our findings indicate, however, that deeper water crayfish also may rely on littoral benthic energy resources. Crayfish movement to deeper waters may be subsidizing generally nutrient poor, deep-water habitats with littoral energy through excretion and egestion, where physical conditions are stable and natural perturbation is low.

In Chapter 2, I quantify the influence of this early, expanding invasion in Crater Lake to littoral zone ecology by evaluating their influence on zoobenthic consumer biomass and basal algal biomass. Benthic invertebrate biomass was 77% lower in hard substrate and 78% lower in soft substrate areas with crayfish present than in crayfish-absent locations. Using Bayesian, stable isotope mixing models, dietary preferences of crayfish at three locations with varying crayfish densities were quantified. Only slight variations in crayfish diet were detected between the three locations where crayfish have been established, the outer boundary of crayfish expansion, and the middle of the crayfish population indicating that crayfish. Despite differing densities, crayfish are feeding on similar food sources, particularly benthic invertebrates. At low crayfish densities (0 to 10), benthic invertebrate numbers were 222.3±36.6 individuals m^{-2}, while chlorophyll *a* was 16.8±5.8 mg m^{-2}. At high densities of crayfish (>50), benthic invertebrates had low mean density 3.0±4.2 individuals m^{-2}, while chlorophyll *a* biomass was high 226.7±48.1 mg m^{-2}. Crayfish are impacting native invertebrate communities and periphyton biomass in Crater Lake by changing trophic interactions in the lake's littoral zone and altering the lake's food web.

In Chapter 3, I focus on the benthic environment and biodiversity of Lake Tahoe and regional lakes (Donner Lake, Marlette Lake, and Fallen Leaf Lake. Signal crayfish were introduced into the Central Sierra Nevada region of the United States in the late 19th to early 20th century. I used a long-term data set to document highly variable crayfish densities in the littoral zone of Lake Tahoe, showing an increase during the summer months linked to an increase in water temperature ($R^2 = 0.69$, $P<0.001$). Crayfish responded to site-specific characteristics of the nearshore rather than to lake-wide characteristics; local stream discharge was the only factor that explained a positive increase in lake densities ($P< 0.04$). Trophic niche models developed from stable isotope measurements of crayfish and nongame fish indicate that crayfish influence the dietary breadth (e.g. niche area) of nongame fish consumers. Crayfish feeding behavior may be forcing nongame fish to feed on a broader set of food resources when crayfish are present. Stable isotope analysis also indicates an overlap of crayfish niche area with other nongame fish and amphibians, indicating interspecific competition between organisms. Our study highlights that local factors influence cold-water crayfish movement and densities in large lakes, as well as potential direct and indirect influences on nongame fish consumers in the littoral region, potentially affecting native biota and ecosystem function.

This research has significant implications for understanding the direct and indirect impacts of signal crayfish in oligotrophic food webs, particularly on benthic invertebrate densities. It expands on the current understanding of expansion of signal crayfish and the factors that influence crayfish density. Future research will need to focus on better understanding the life history and mechanisms controlling this species if they are to be controlled in lakes of the Western United States.

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Chapter 1. Expansion, habitat occupancy, and food web interactions of invasive crayfish in a large ultra-oligotrophic lake

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Abstract

Invasive crayfish (*Pacifastacus leniusculus*) in Crater Lake, a deep sub-alpine lake in southern Oregon (USA), have been expanding in the littoral zone following introduction nearly 100 years ago. Depth gradient minnow traps demonstrate that crayfish densities can live as deep as 250 m. Trap and snorkel surveys from 2008 to 2013 indicate an expansion of crayfish from 44% to 78% of the littoral zone. Summer water temperature in Crater Lake has been warming, between 1965 and 2014 the temperature has increased by 3.5°C; nearshore-surface warming may increase the recruitment of individuals and expand habitat availability for growth. Near the invasion fronts of the expanding littoral zone population, crayfish size was larger than in the middle of the population, indicating that large crayfish may be responsible for colonizing new habitats. Principal component analysis revealed a positive relationship (first two axes explained 74% of the variation) between crayfish occupation and cobble and boulder habitats of the lake, similar to findings from other ecosystems. We used stable isotope ratios of $\delta^{13}C$ and $\delta^{15}N$ to determine the flow of organic matter through the food web, trophic position, and percent benthic reliance. As expected, crayfish living in the nearshore rely heavily (97.4%) on littoral-benthic carbon sources indicating their potential for impacting native invertebrate communities and overall dynamics of Crater Lake's ecosystem. However, our findings also indicate that deeper water crayfish may rely on littoral benthic energy resources. This movement to deeper waters may be subsidizing generally nutrient poor, deep-water habitats with littoral energy through excretion and egestion, where physical conditions are stable and natural perturbation is low.

Key Words: Introduced species, signal crayfish, stable isotope, benthic food web

Introduction

Invasive species have caused numerous ecological problems controlling ecosystem dynamics (Perry et al. 2005). Some of the earliest movement of aquatic invasive species from regions across the globe resulted from food-related transportation vectors, game species transportation, and “bait bucket” releases into novel ecosystems (Lockwood et al. 2005). These human-engineered introductions often result in rapid colonization over larger geographical ranges that would not occur naturally (Lockwood et al. 2005).

Crayfish are one of the most widely introduced species globally (Lodge et al. 2000). They are a very diverse group of decapods with over 640 species (Crandall and Buhay 2008) occupying a broad range of habitats from small streams to large rivers and lakes of varying trophic condition. Widely recognized as a key component in food webs, regulating nutrient cycling and the transfer of energy from the benthos to higher consumers (Lodge and Hill 1994, Evans-White et al. 2001), crayfish constitute important components of many temperate lake and stream ecosystems because of their high biomass, omnivory, and importance as prey items for multiple fish species (Momot et al. 1978, Lodge and Hill 1994, Momot 1995, Nystrom 2002). Primarily as a function of their foraging habits, crayfish can strongly influence lake littoral habitats and food web composition (Lodge et al. 1994, Guan and Wiles 1996, Usio and Townsend 2000, Ercoli et al. 2015).

Previous studies have identified substrate as the primary limiting factor for crayfish distribution and have found that it can play a significant role in crayfish population size (Nystrom et al. 2006). Cobble and boulder can provide refuges from both fish predation, cannibalism, and cell damage from ultraviolet light. Once established, crayfish can expand rapidly to become the dominant benthic consumer (Snyder and Evans 2006, Hudina and Hock 2012). In low nutrient lakes they can come to dominate both benthic biomass and functional ecological roles (Momot et al. 1978). Annual crayfish production can exceed hundreds of kilograms per hectare, and crayfish biomass production and consumption will often exceed the production and consumption of all other benthic invertebrates combined (Momot 1995, Whitledge and Rabeni 1997, Ruokonen et al. 2012). Although habitat preference and movement in small eutrophic lakes and rivers are well known (Lodge et al. 1986, Light et al. 1995, Taylor et al. 2007), little is known about crayfish movement, habitat preference, and impacts on native food webs in nutrient limited, large oligotrophic lake ecosystems.

There is very little understanding of crayfish movement in lentic ecosystems due to the rapid nature of colonization of the nearshore once crayfish are introduced. Hundina et al. (2009) includes a literature review of recorded signal crayfish dispersal rates from seven streams and one lake with dispersal rates ranging from 350 to 7000 m/yr with most of the rates less than 2000 m/yr. Other studies have found that crayfish are capable of moving long distances in lotic ecosystems (Byron and Wilson 2001, Bubb et al. 2004, Light 2003, Bubb et al. 2006, Moorhouse and MacDonald 2011, Wutz and Geist 2013). Colonization of signal crayfish into unoccupied habitat is likely to be density dependent. That is, crayfish are not likely to keep moving once they enter an unoccupied area with overhead cover and food. However, intraspecific interactions between crayfish are thought to instigate movements (Bubb et al. 2004), including a movement preference by large females in order to avoid contact between progeny and large cannibalistic males (Almeida et al. 2013). Likewise, recent mark-recapture and pit/radio tag movement studies suggest that large crayfish move longer distances than smaller crayfish (Moorhouse and MacDonald 2011, Light 2003, Wutz and Geist 2013).

Growth rates, abundances, and increased reproduction of many aquatic organisms have been correlated with changes in temperature (Adrian et al. 2006, Winder and Hunter 2008). Numerous studies have shown that crayfish activity is temperature dependent (Flint and Goldman 1975, Lozan 2000, Barbaresi and Gherardi 2002, Bubb et al. 2002, Bubb et al. 2004, Aquilioni and Gherardi 2005, Rosewarne et al. 2013, Johnson and Rice 2014, Nystrom et al. 1996). Rutledge and Pritchard (1981) showed that the activity of signal crayfish increases dramatically at water temperatures between 8 and 15°C and was maximized at 20°C. Since 1965, the surface temperature in Crater Lake has risen due to warming air temperature, and this increase may allow crayfish to move faster into novel habitat and increase reproduction (this study, see below).

Signal crayfish (*Pacifastacus leniusculus*) were introduced into the lake in 1915 from 2 locations (Odell Lake and Sprague River, OR) as a food source for introduced fish (Steel 1915). Before introduction of fish and crayfish, rough-skinned newts (*Taricha granulosa mazamae*) were presumably the top aquatic predator in the system. It is believed that the newts are an endemic subspecies that are morphologically, genetically, and physiologically distinct from populations outside the Crater Lake caldera (Buktenica et al. 2015).

Using an opportunity to study an early invasion and expansion of crayfish in a nutrient poor ecosystem, the objectives of this study are to quantify 1) the interannual changes of crayfish occupation by a depth gradient, 2) annual lateral expansion in the littoral zone, 3) the habitat preferences in the littoral zone during and the characteristics of the expanding population (weight and gender), and 4) the energetic contributions of the littoral zone to the lake food web structure with a focus of the energy used by an invading and expanding population of crayfish and potential ecological consequences (competition, predation) on the native newt.

Methods

Study Area

Crater Lake is a large, deep ultra-oligotrophic lake (mean summer Secchi depth 30 m) located in the Cascade Range in southern Oregon, USA. The caldera of Mount Mazama, formed 7,700 years ago, is a terminal basin with no major inlets (Bacon et al. 2002). The lake has a maximum depth of 594 m, a mean depth of 350 m, and a volume of 19 km^3 (Bacon et al. 2002). The walls of the caldera are steep with high slope gradients; therefore, littoral areas around the lake are minimal (Bacon et al. 2002) and light compensation depth occurs between 80 and 100 m (Larson 1996). Established as a National Park in 1902, a concern that the clarity of the lake may be declining resulted in the establishment of a long-term monitoring program in 1982 (Larson 1996). The goals of the program are to establish a baseline for future studies, and evaluate the relationships among physical, chemical, and biological features (Larson 1996).

Crayfish Distribution from Littoral to Profundal Habitats

Five spatially distributed sites were sampled with shallow to deeper waters to determine vertical depth distribution and density from 2008-2013 (Figure 1-1). Paired cylindrical, wire-mesh crayfish traps (0.42 m long x 0.21 m diameter with two 60 mm openings) were used to determine density of crayfish. Density was estimated as the catch per unit effort (CPUE) calculated as the mean number of crayfish caught in the two traps divided by the number of hours of trapping time. Two traps were deployed overnight (approximate 18 hours) on the lake bottom at depths 3, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 125, 150, 175, 200, and 250 m. No crayfish were caught at Chaski Slide and Spring 7, and only above 10 meters at Steel Bay and Wizard Island during the summer of 2008 (Table 1-1). All 5 transects were sampled in July of 2009, but again no crayfish were caught and long-line trapping only continued at Cleetwood Cove in September for the remainder of the study. Preliminary field investigations between bait types revealed that traps baited with fish had a higher catch rate than dog food and therefore all future traps were baited with equal portions of fish. For all traps, number of individuals, gender, carapace lengths, and weights were collected along with a subset of tail muscle plugs for stable isotope analysis described below. One-way Analysis Of Variance (ANOVA) was utilized to determine differences between weights at boundary and middle population locations. We defined the boundaries as the 1 or 2 outermost locations for each year on each side of the expansion and the middle was defined as the 4 sites in the middle of the crayfish distribution.

Crayfish Lateral Movement and Habitat Preference within the Littoral Habitat

To determine spatial distribution, movement, and size structure of crayfish in the Crater Lake littoral zone, we used two methods to quantify distribution, baited minnow traps and snorkel observations. Two baited minnow traps were deployed overnight (approximately 18 hours) at 39 locations around the lake at 1000 m intervals. These traps were set between 1-2 m depth around the perimeter of the lake in July and September between 2008 through 2010, then only in September between 2011 and 2013. Studies from Lake Tahoe (CA-NV USA) suggest that crayfish migrate to the shallow waters in late summer, September or October (Flint and Goldman 1975, Umek and Chandra unpublished data), thus we feel comparisons of interannual densities from the littoral zone during late summer (September) represent changes in the density of the population over time.

While it is the most common method for crayfish sampling, use of baited traps has some limitations worth noting and may not be the best method for determining crayfish expansion in lake littoral zones. For example, minnow traps may not capture individuals arriving at new locations, as there may be ample food in the new area, and there may be a lag time before a detection threshold is crossed before traps capture crayfish (Lockwood et al. 2005). Therefore, in addition to nearshore crayfish trap sampling snorkel surveys were also performed as two snorkelers swam in opposite directions for 10 min in 1 m deep water at nearshore trap locations, turning over rocks and recording the total count of crayfish observed. Snorkelers also classified substrate based on the Wolman pebble count. The relationship between trap CPUE and density around the trap is difficult to determine and therefore both methods were employed to detect crayfish. Using Program R (version 2.11.1; R Development Core Team, Vienna, Austria), we applied Principal Components Analysis (PCA) on correlation matrices to describe the relationships between the species density and substrate types that influence the structure of the crayfish community.

Surface Temperature

Year round near-surface water temperature has been collected at two locations allowing for the quantification of temperature change over time. Between 1964 and 2003, mean daily surface temperature was collected at a USGS lake level gauge on the shoreline at Cleetwood Cove (Figure 1-1). The probe was located at an approximate water depth of 5 m (elevation 1876.7 m). Beginning in 1992, hourly surface temperatures have been collected at a floating weather buoy moored in the deep basin of the lake at station 13 (Figure 1-1). Comparison of daily Cleetwood Cove gauge and weather buoy readings over an 11-year period (1992 - 2002) results in an $R^2 = 0.98$ and a slope of 0.97 ($n = 3790$). On average the Cleetwood Cove gauge reads 0.2°C higher than the weather buoy between July and September, with lake elevation having no effect.

Quantifying Crayfish feeding Behavior and Food Web Structure Using Stable Isotope and Gut Content Measurements

Isotopic $\delta^{13}C$ has been used frequently to determine the flow of organic matter through food. The minimal enrichment (± 0.47 ‰) from lower to higher trophic levels allow for the differentiation of benthic-littoral and pelagic primary production sources (Vander Zanden and Rasmussen 2001). There is typically a 3-4‰ increase in $\delta^{15}N$ from prey to predator, such that $\delta^{15}N$ can be used to estimate consumer trophic position (Minagawa and Wada 1984; Cabana and Rasmussen 1996; Vander Zanden and Rasmussen 2001). Ethanol preservation has a minimal affect on natural abundance stable isotope signatures, so no correction was applied to the invertebrate collections (Edwards et al. 2002, Sarakinos et al. 2002).

Biological samples were collected for isotope analysis in 2008, 2009, and 2012. Benthic invertebrates (Gastropoda, Chironomidae, and Trichoptera) for stable isotope analysis were collected from soft substrate from discrete depths (3- 581m) using a Shipek grab sampler (area 0.039 m^2) from Cleetwood Cove (Figure 1-1); these collections are along the transect where crayfish were collected at depth. Benthic invertebrates on hard substrate were sampled using a benthic suction device within crayfish present and absent locations.

All benthic invertebrate samples were sieved through 500 um mesh, picked immediately, and stored in 70% ethanol. In the laboratory, Gastropoda and Oligochaeta samples were sorted to the class level, while Chironomidae were sorted to family and Trichoptera were sorted to order. After identification, invertebrate individual of similar taxonomic grouping and grab depth were pooled together into a single sample for isotope analysis. We also present a mean of signatures from discrete habitats defined as eulittoral 0 to 10 m, sublittoral 10 to 100 m, and profundal >100 m that were characterized post hoc. To minimize potential ontogenetic diet changes, we measured stable isotopes from crayfish of similar size (carapace length; 41.2 mm ± 1.1). Differences in crayfish stable isotope samples collected in 2008 and 2009 were not significant ($P<0.10$) between years and were therefore combined for statistical analysis.

Higher-level consumer such as fishes and newts were collected for isotope measurements. Fishes were collected using gill nets, set monthly during summer as part of the routine monitoring program for the National Park, at two locations (Eagle Point and Chaski Slide: Figure 1-1). Fish were identified to species (kokanee- *Oncorhynchus nerka* or rainbow trout- *O. mykiss*), measured for length and weight, gut content, and dorsal muscle tissue samples were collected for isotope analysis preserved in 70% ethanol. Newts were collected using minnow traps and the toe muscle was utilized for isotope measurements and preserved in 70% ethanol.

Tissue samples were dried at 60°C for at least 24 hours then ground into a fine powder by mortar and pestle. Samples collected in 2008 and 2009 were packed into tin capsules (8 x 5 mm) and analyzed for $\delta^{13}C$ and $\delta^{15}N$ at the University of Nevada Reno using a Eurovector elemental analyzer (Eurovector S.p.A, Milan, Italy) interfaced to a Micromass Isoprime stable isotope ratio mass spectrometer (Micromass UK Ltd., Manchester, United Kingdom. Sample combustion to CO_2 occurred at 1000°C in an inline elemental analyzer (PDZEuropa Scientific, ANCA-GSL). The gases were separated on a Carbosieve G column (Supelco, Bellefonte, PA, USA) before introduction to the IRMS. Samples collected in 2012, were measured at Southern Oregon University. These samples were combusted on an elemental analyzer (Elementar Vario Pyro-cube, Mt. Laurel NJ) coupled to an Isoprime (model 100, Stockport UK) isotope ratio mass spectrometer. Isotopic ratio is expressed as a per mil (‰) deviation as presented in Chandra et al. (2005).

To aid in interpretation, the energetic dependency of crayfish and newts was quantified using a two-end member-mixing model of the $\delta^{13}C$ data (Chandra et al. 2005). Percent littoral-benthic reliance was estimated as follows:

% Littoral-benthic = $[(\delta^{13}C_{consumer} - \delta^{13}C_{pelagic})/(\delta^{13}C_{benthic\ consumer} - \delta^{13}C_{pelagic})]*100$, where $\delta^{13}C_{consumer}$ is the $\delta^{13}C$ value of the crayfish or newt, $\delta^{13}C_{benthic}$ is the mean $\delta^{13}C$ of eulittoral Chironomidae, Gastropoda, and Trichoptera (-7.9) representing the eulittoral-benthic end-member (0 to 10m), and the pelagic end-member is the mean $\delta^{13}C$ of zooplankton (-31.2‰) represented by $\delta^{13}C_{pelagic}$. Because $\delta^{13}C$ is conserved with little fractionation from prey to consumer, obligate primary consumers in the benthic (e.g. eulittoral Chironomidae, Gastropoda, and Trichoptera) and pelagic habitats (e.g. zooplankton) should be isotopically similar to primary production in their respective environments (Vander Zanden and Rasmussen 1999).

Energy Utilization of Crayfish from Shallow to Deeper Waters Compared with Less Mobile Primary Consumers

Previous research from another deep lake ecosystem, Lake Tahoe, suggests primary consumers such as Chironomidae or Oligochaeta reflect the signature of primary producers (e.g. periphyton versus phytoplankton) supporting the consumer at a given depth (Chandra et al. 2005, Vander Zanden et al. 2003). To understand whether mobile benthic consumers like crayfish use littoral-benthic sources versus deep-water profundal sources for their energy, we compared isotopic signals of less mobile invertebrates like Chironomidae to the more mobile crayfish across shallow (3 m) to profundal depths (581 m). We assumed Chironomidae would be considered a less mobile consumer representing a signal of production from a local, discrete depth (e.g. 3, 20, 50, 100 m, etc.). A linear fit was used because the data were log transformed to normalize $\delta^{13}C$ and $\delta^{15}N$ values for Chironomidae and crayfish. We tested for differences between Chironomidae and crayfish isotope signatures across a depth gradient using an analysis of covariance (ANCOVA). Analyses were conducted using Program R (version 2.11.1; R Development Core Team, Vienna, Austria),

Results

Crayfish Distribution from Littoral to Profundal Habitats

Density of crayfish increased through the summer (July to September) at Cleetwood Cove in 2008, 2009, and 2010 with density highest at shallow depths, decreasing gradually to 250 m (Table 1-1). Crayfish were found exclusively at and above 10 m at Steel Bay and Wizard Island in 2008 and 2009; longline sampling did not continue at these locations after 2009 (Table 1-1). The majority of crayfish caught at Cleetwood Cove were above 100 m with a main peak at or above 10 m. However, crayfish were found as deep as 250 m in September of 2009, 2011, and 2013 (Figure 1-2). Secondary peaks in density occurred between 40-100 m but were not at a consistent depth. These secondary peaks may correspond to the deep chlorophyll maxima of the lake. Within the littoral zone, the largest concentrations of crayfish were found around Cleetwood Cove in the northern part of Crater Lake (sites G-O) and around Wizard Island in the southwest (Figure 1-3). A small population was also found on the southwest shore of Crater Lake (sites 2 and 14), across from Wizard Island.

Crayfish and Newt Habitat Preference

Snorkel observations in 2008, 2011, 2012, and 2013 were combined to determine habitat preference of crayfish and newts. Both crayfish and newts were positively associated with areas of boulder and cobble and a negatively associated with areas of sand and gravel (Figure 1-4). The PCA for crayfish substrate occupation was significant (Figure 1-4a), with the first two axes explaining 74% of the variation. The PCA for newt substrate occupation was also significant (Figure 1-4b), with the first two axes explaining 67% of the variation, which also preferred cobble and boulder substrate.

Lateral Movement Along the Littoral Zone

Between August and September 2008 crayfish were detected 1000 m to the west from location G to F and 1000 m to the east from location M to N using minnow traps (Figure 1-5a). In June 2009, crayfish were detected at the same locations as in August 2008 on the west side but were not detected at the same boundary locations on the east side. In 2009, crayfish were detected on the east side in July at location M and in September detected at locations between O and P, a difference of 3000 m (Figure 1-5b). In June 2010, crayfish were detected at location N, a deviation of 1500 m from September 2009 (Figure 1-5c).

The 2008 snorkel survey indicated crayfish occupied 44% of the littoral zone (Figure 1-5). During the 2011 snorkel surveys, crayfish were observed at 7 new locations (sites D and E on the Western Boundary; and P, Q, R, T, and X on the Eastern Boundary) increasing the littoral zone occupation to 62%. Crayfish were observed at 2 new locations during the 2012 snorkel survey (sites B and U) increasing the nearshore occupancy to 64%; by 2013, crayfish were observed at 4 new locations occupying 78% of the littoral zone, the broadest distribution to date (Figure 1-5d).

Crayfish at the boundaries were significantly heavier than crayfish in the middle of the population except in 2009 and 2010 ($P < 0.001$; Figure 1-6). As is typical for many crayfish populations, and explained by the need for females to have larger tails in order to carry and protect eggs (Huxley 1879), female crayfish were larger than males in terms of the size frequency of carapace lengths (39.7 ± 5.6 compared to 38.4 ± 5.6 mm, respectively) and weighed more (18.4 ± 7.5 g versus 17.8 ± 7.6 g, respectively).

Surface Temperature

Mean annual surface water temperature in Crater Lake is 7.5°C, with average summertime surface temperature reaching approximately 16°C (1965-2013; Figure 1-7). The near-surface water temperature only gets above 10°C for approximately 16 weeks during summer months (1992-2014) and on average only 4 weeks above 15.5°C. Additionally, the summer thermocline is relatively shallow (10-15 m) so only a narrow region at the surface gets warm. Of the 25 years prior to 1990, two (87%) had mean summer surface temperatures over 14°C. Since then, 19 of the 25 years (76%) were warmer than 14°C. Annual water temperature at 20 m is 5.6°C, and everything below 50 m is less than 4.4°C on average.

Food Web Interactions Quantified Using Gut Contents and Stable Isotope Measurements

Forty-four rainbow trout stomachs were analyzed for diet contents. Trichoptera accounted for 22% of the gut content proportion, while diptera and hymenoptera accounted for 20%. Coleoptera accounted for 18% of the diet. No crayfish were found in the 47 trout stomachs collected from the gill nets. Isotopic $\delta^{13}C$ values for consumers ranged from depleted -24.9 ‰ (kokanee, n=13) and -31.2 ‰ (zooplankton, n=7) in the two pelagic samples, to enriched -5.8 ‰ (Gastropoda) in the benthic zone (Table 1-2; Figure 1-8). Crayfish occupied the highest trophic position after kokanee ($\delta^{15}N$=6.7 ‰), rainbow trout ($\delta^{15}N$=6.5 ‰), and newts ($\delta^{15}N$=5.54 ‰) with $\delta^{15}N$ between 4.5 and 4.8 ‰ from various sites and depths. $\delta\ ^{13}C$ values for the benthic end-member (mean eulittoral Chironomidae, Gastropoda, and Trichoptera; n=31, $\delta^{13}C$ = -7.9 ‰) and pelagic end-member (zooplankton composite sample; $\delta^{13}C$= -31.2 ‰) indicated that rainbow trout derived energy mainly from the benthic food web (88.0 %) while Kokanee salmon relied to a greater amount on pelagic energy sources (73.0 %; Table 1-2). Both crayfish (97.4 %) and newts (99.4 %) relied on benthic sources (Table 1-2).

Energy Utilization of Crayfish from Shallow to Deeper Waters Compared with Less Mobile Primary Consumers

Crayfish and Chironomidae $\delta^{13}C$ and $\delta^{15}N$ regressions significantly differed by depth (F = 32.5; $P = 1.9e^{-7}$; and F = 16.6; P = 0.0001; Table 1-3). Over the same depth range as Chironomidae, crayfish $\delta^{13}C$ tissue was slightly depleted, from -8.5 ‰ at 0 to 10 m to -11.8 ‰ at 250 m (Figure 1-9a) while crayfish $\delta^{15}N$ decreased slightly from 4.8 ‰at 0 to 10 m to 4.5 ‰ at 250 m (Figure 1-9b). Chironomidae $\delta^{13}C$ values, however, is largely depleted with depth from -6.9 ‰ at 0 to 10 m to -27.3 ‰ at greater then100 m (Figure 1-9a) while δ^{15}N increased from -0.5 at 0 to 10 m to 3.7 at depths greater then 100 m (Figure 1-9b).

Discussion

Crayfish Distribution from Littoral to Profundal Habitats

Crayfish were discovered to a depth of 250 m at Cleetwood Cove, which to our knowledge is the deepest crayfish have been recorded. A deep-water peak in primary production common to lakes of high clarity, may explain the secondary peak of crayfish found at deeper depths (McIntire et al. 1994). At Wizard Island and Steel Bay, crayfish were found exclusively at or above 10 m. The restriction of crayfish above 10 m at Wizard Island is likely due to a change in substrate type from cobble to soft flocculent sediment, leaving virtually no interstitial spaces for crayfish to avoid either predation or ultra-violet light. The volcanic rock habitat above 10 m in the Wizard Island nearshore contains extensive interstitial habitat. Long-lines and nearshore surveys for crayfish distribution in Crater Lake affirmed that crayfish were concentrated at two locations, Cleetwood Cove and Wizard Island. However, the unoccupied areas beyond the current distribution contain suitable substrate, making it unlikely that a lack of available habitat has been or is limiting expansion.

Habitat Preference in the Littoral Zone

Previous studies have identified substrate as the primary limiting factor for crayfish distribution and found that it can play a significant role in crayfish population size (Nystrom et al. 2006). Similar to these findings, crayfish in Crater Lake preferred cobble and boulder habitats. Cobble and boulder can provide refuges from both fish predation, cannibalism, and ultraviolet damage. We do not know if population densities in ultra-oligotrophic Crater Lake, particularly at the boundary areas, have reached maximum carrying capacity. In certain systems the abundance of cobble sets the upper limit of crayfish abundance (Capelli and Mannuson 1983, Lodge and Hill 1994, Guan and Wiles 1996, Kirjavainen and Westman 1999). One potential explanation for the recent increase in crayfish expansion in Crater Lake is the possibility that crayfish are reaching their maximum carrying capacity forcing crayfish to move to other areas for food and or preferred substrate. Expansion and contraction patterns observed between sampling periods may be indicative of interannual colonization dynamics that could be influencing nearshore lake dynamics. The National Park Service monitoring program is limited only to summer sampling due to safety issues with lake access during the rest of the year. Understanding potential interannual expansion and contraction in fall and winter and mechanisms resulting in range constriction may be important when quantifying the influence of crayfish on the littoral zone year round.

Colonization of signal crayfish into unoccupied habitat may be density dependent. Intraspecific interactions between crayfish are thought to instigate movements (Bubb et al. 2004), including a movement preference by large females in order to avoid contact between progeny and large cannibalistic males (Almeida et al. 2013). Likewise, recent mark-recapture and pit/radio tag movement studies suggest that large crayfish move more than smaller crayfish (Moorhouse and MacDonald 2011, Light 2003, Wutz and Geist 2013), similar to our findings at Crater Lake.

Lateral Movement Along the Littoral Zone

The lateral distribution of crayfish along the littoral zone habitat in Crater Lake showed two primary locations where these invasive species are present, the north shore at Cleetwood Cove (middle population) and Wizard Island. Between 2008 and 2011, crayfish occupancy in the littoral zone increased from 44% to 62%, expanding on both the eastern and western boundaries and by 2013 crayfish were observed occupying 78% of the littoral zone, the broadest distribution to date.

Previous research has found that crayfish are capable of moving long distances in lotic ecosystems ranging from 200 to 7000 m/yr., although most are less than 2000 m/yr. (Byron and Wilson 2001, Bubb et al. 2004, Hundina et al. 2009, Bryon and Wilson 2001, Light 2003, Bubb et al. 2006, Moorhouse and MacDonald 2011, Wutz and Geist 2013). The north shore population in Crater Lake has dispersed approximately 85 m/yr on average, assuming the extent of the present distribution represents equal lateral movement from a central location over 99 years. We hypothesize that several physical characteristics of Crater Lake result in slower crayfish dispersal compared to other systems.

There are multiple physical impediments to movement in Crater Lake that might have slowed spread of the north shore crayfish as well as crayfish on Wizard Island. Several nearshore areas along the north shore of Crater Lake include extremely steep cliff bands with no overhead cover, which likely slows crayfish spread. At Wizard Island, the combination of the surrounding soft sediments and deep water may have functionally restricted expansion off the Island to the relatively shallow area of Skell channel on the west side. All of Wizard Island except for Skell channel on the westernmost point is surrounded by water greater than 90 m deep. Average water temperature at this depth is less than 4.0°C, a temperature which greatly limits crayfish movements (Bubb et al. 2004). Likewise extensive areas of soft sediments surround all of Wizard Island, except for the shallowest 850 m long stretch of Skell Channel, with little if any overhead rock substrate. Crayfish and crayfish tracks are very rarely observed in the soft sediments around Wizard Island (Buktenica personal observations) even though some of the highest crayfish densities in Crater Lake are observed within the rock substrate immediately above.

From the Cleetwood Cove population in Crater Lake, assuming the extent of the present distribution represents equal lateral movement from a central location over 99 years, crayfish have dispersed approximately 85 m/yr. on average. Our data indicate there is variation in dispersal rates between years, however. If we only account for dispersal rates during our study (2008 – 2013) lateral movement was 1666 m/yr. on average, indicating a precipitous recent expansion.

Habitat structure differences in the nearshore may also explain differences in crayfish spatial distribution around the littoral zone, as research has shown crayfish have a preference for cobble and boulder (Nystrom et al. 2006, Ruokonen et al. 2014). The overall increase in distribution between 2008 and 2013 was from 44% to 78% with low densities of crayfish found in the margins of the expansion. Unlike Wizard Island, where the current extent of the population coincides with suitable available substrate, optimal substrate continues well beyond where crayfish were captured. This appears to be early colonization of novel habitat.

Warming temperature may influence crayfish expansion?

The physical setting of Crater Lake along the crest of the Oregon Cascade Mountains at 1,882 m elevation results in cold overall water temperature most of the year. At the most fundamental level, the increase in surface temperature from climate change results in shifts to biological communities impacting basic biological processes, such as metabolism or reproduction. The rise in surface temperatures may explain why crayfish are now only colonizing the nearshore. Rutledge and Pritchard (1981) showed that the activity of signal crayfish was maximized at 20°C and increases dramatically at water temperatures of between 8 and 15°C. Since 1965, the surface temperature in Crater Lake has risen from 12.09°C to 15.56°C recorded in 2014. An analysis of temperature records from Crater Lake indicate that mean annual surface water temperature in Crater Lake is 7.5°C with maximum summertime surface temperature approximately 16°C (1965-2013).

Numerous studies have shown that crayfish activity is positively temperature dependent (Flint and Goldman 1975, Lozan 2000, Barbaresi and Gherardi 2001, Bubb et al., 2002, Aquilioni et al. 2005, Bubb et al. 2004, Rosewarne et al. 2013, Johnson et al. 2014). Activity levels in signal crayfish from Lake Tahoe were about 4 times higher at 20°C than at 4°C (Lozan 2000). Likewise, Bubb et al. (2004) showed an almost logarithmic relationship between temperature and movement in radio-tagged signal crayfish, with very little movement at 4°C, and only slightly higher around 7°C, but progressively increased movement between 12°C and 16°C. Temperature records from Crater Lake show mean annual surface water temperature in Crater Lake is only 7.5°C with maximum summertime surface temperature approximately 16°C (1965-2013). Additionally, the summer thermocline is relatively shallow (10-15 m) so only a narrow region at the surface gets warm in the summer. Bubb et al. (2002) found that crayfish stopped making long distance movements when water temperature dropped to an average of 4.2°C yet crayfish are found below the thermocline and moving to traps for food. Annual water temperature at 20 m is only 5.6°C, and everything below 50 m is less than 4.4°C on average. Even at the surface, water temperature only gets above 10°C for approximately 16 weeks during summer (1992-2013) and only 4 weeks on average above 15.5°C. The cooler temperatures associated with Crater Lake may be the reason for the delayed expansion of crayfish in the nearshore and for the lower numbers at lower depths. Activity levels in signal crayfish from Lake Tahoe were about 4 times higher at 20°C than 4°C (Lozan 2000). Likewise, Bubb et al. (2004) found an almost logarithmic relationship between temperature and movement in radio-tagged signal crayfish in lentic ecosystems, with very little movement at 4°C, slightly higher around 7°C, but progressively increased between 12°C and 16°C. Even at the surface, water temperature between 1992 and 2014 only gets above 10°C for approximately 16 weeks during summer and only 4 weeks on average above 15.5°C.

Only recently has the temperature in the nearshore increased to a level that allows an increase in activity and reproduction. Aydin and Dilek (2004) found that temperature increases from 11.8°C to 16°C increased egg survival from 22.4% to 46.9% for *Astacus* *leptodactylus* crayfish. The increase in temperature from 1965 could have allowed higher survival of crayfish to (ie. egg survival). This might account for the higher crayfish expansion in the nearshore as locations reach maximum occupancy.

Food Web Interactions Emphasizing Invasive Crayfish and Native Newt Energetics

Crayfish dynamics, habitat and food preference, and seasonal physiological constraints may also govern newt habitat and food preference. Crayfish may be competing with endemic newts for interstitial habitat and displacing individual newts, similar to findings that found negative relationships between abundance of fish and crayfish populations in streams (Guan and Wiles 1997, Peay 2009). Crayfish are a potential predator to native amphibians (Axelsson et al. 1997, Gamradt and Kats 1996, Gamradt et al. 1997) and direct predation on both adults and larvae may be occurring in Crater Lake. The displacement of newts from preferred habitat by crayfish could, in turn, make newts more vulnerable to predatory trout. Certain benthic invertebrates, such as Gastropoda, also prefer cobble and boulder habitats and crayfish may therefore not have to move from protected habitats to obtain preferred food sources (Nystrom Perez 1998, Stenroth and Nystrom 2003). Crayfish (97.4 %) and newts (99.4 %) both rely on benthic food sources suggesting interspecific competition for resources. The taxonomy and associated endemism of the newts collected in Crater Lake has yet to be resolved conclusively; however, given that isotopic data indicates the likelihood of direct resource and habitat competition with crayfish, the expansion of the crayfish and interaction with newts is of primary conservation concern, given the potential for the newt to be an endemic sub-species, The isotopic data indicate fishes are the top consumer in the Crater Lake food web (Figure 1-8). Based on $\delta^{13}C$ measurements, kokanee are highly planktivorous while rainbow trout feed more so on littoral-benthic food resources. This finding is consistent with fish diet data presented by Buktenica et al. (2007) for Crater Lake. Rainbow trout may obtain some energy from crayfish or newts; however, qualitative stomach content examination suggests little to no crayfish in their diets during our sampling period from the locations we sampled trout. Potential explanations for the apparently low predation frequency on crayfish by rainbow trout include relatively low encounter rates with crayfish due to their lower densities and high abundance of other, benthic invertebrate prey. If crayfish populations have direct and indirect impacts on benthic invertebrates composition and production it may be important to investigate predator-prey interactions between rainbow trout and crayfish populations in the future.

Crayfish at Depth as Sinks of Energy or Potential Sources of Nutrients to the Profundal Habitat?

Our isotopic data suggests that Chironomidae in the nearshore zone (above 5 m) rely on littoral benthic algal sources. A shift to a mix of benthic algae and phytoplankton food sources occurs with increasing depth in the sublittoral habitat. Deeper than 100 m, the Chironomidae receive almost all of their energy from pelagic (phytoplankton) food resources which settle of focus to the lake bottom. This finding is consistent with Chandra et al. (2005) who found a similar coupling of pelagic resources to deep-water invertebrates in Lake Tahoe. Crayfish collected across the same gradient have a littoral isotopic carbon signal that only slightly changes with depth and did not have a profundal signal like Chironomidae. While crayfish nitrogen signal decreased slightly, Chironomidae nitrogen signal increased from -0.5 ‰ in the eulittoral zone to 3.7 ‰ in the profundal zone. Grey et al. (2004) and Sierszen et al (2006) also found similar results with a depletion in δ^{13}C and an increase in Chironomidae δ^{15}N by depth. An increase in nitrate by depth in Crater Lake could be a result of isotopic fractionation during microbial nitrogen transformation and phytoplankton assimilation that may explain the increase in Chironomidae δ^{15}N by depth (Hadas et al 2009, Gu 2009, Figure 1-10;).

Historically, littoral and pelagic habitats have been thought to have discrete food webs, however recent research has shown that movement of energy across these boundaries by taxa can integrate these habitats (Vander Zanden and Vadeboncoeur 2002, Vanni 2002, Seminoff et al 2012, Kreps et al 2016). Crayfish movement to deeper waters at shorter time scales may be subsidizing, already nutrient poor, deep-water habitats through excretion and egestion of nutrients (Vanni 2002), where physical conditions are stable and natural perturbation is low (Stendera and Johnson 2008). If they do not migrate to shallow water, they may serve as an organic nutrient source to the sediment microbial community.

Considering isotopic signals should represent a period of 4-6 month tissue turnover, our findings indicate that deeper water crayfish are reliant on littoral benthic resources of energy but migrate to deeper waters on shorter time scales (weeks to months) during summer. A second hypothesis for consideration is crayfish may not be able to move back up into the littoral zone due to the steep gradient, nevertheless crayfish have retained the littoral signature from the food consumed before moving into the deeper water. The analysis does suggest that crayfish do not rely on energy from high level consumers such as trout in either the littoral zone or from carrion trout sinking, once dead, to the deeper depths. If crayfish were eating kokanee that have died and sunk to deeper depths, they would have a pelagic signal indicating that crayfish are not eating trout at these deeper depths.

Biologists are currently attempting to understand impacts of climate change on the movement and impacts of invasive species to predict future invasions. Crayfish expansion around Crater Lake may influence the littoral zone food webs and the link between the littoral and profundal zone, impacting the overall dynamics of the lake ecosystem (Wetzel 1983, Carpenter and Lodge 1986). Expansion of a crayfish population in an ultra-oligotrophic lake has not been documented, nor following a lag time of almost 100 years after initial introduction. Further investigation related to the direct and indirect impacts of crayfish on benthic invertebrates and the endemic newt population in Crater Lake is suggested. Complete eradication of crayfish populations in large lakes may not be feasible and prevention of expansion has proven difficult, however, studies have shown decreases in population densities with increased trapping efforts (Hein et al. 2006). Intensive trapping efforts, particularly in cobble and boulder substrates, could curb population growth of crayfish that would in turn benefit newt and benthic invertebrate populations within Crater Lake.

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Table 1-1. Catch per unit effort (CPUE, as a measure of density) and total number of crayfish captured at depth from 5 locations around Crater Lake in the summer of 2008 and 2009. Crayfish caught at Steel Bay and Wizard Island were all trapped at <10 m depths.

Month	**Cleetwood Cove**	**Steel Bay**	**Spring 7**	**Chaski**	**Wizard Is.**
July 2008	9.2 (175)	0	0	0	0
August 2008	16.1 (290)	0	0	0	0.8 (14*)
September 2008	22.6 (406)	1.7 (32*)	0	0	3.1 (55*)
July 2009	9.7 (176)	0	NS	NS	ς0
September 2009	15.7 (282)	NS	NS	NS	NS
June 2010	27.1 (487)	NS	NS	NS	NS
September 2010	26.9 (485)	NS	NS	NS	NS
September 2011	37.9 (683)	NS	NS	NS	NS
September 2012	26.6 (479)	NS	NS	NS	NS
September 2013	29.8 (536)	NS	NS	NS	NS

*Indicates crayfish caught only between 3 and 10 meters.

Table 1-2. Mean (±SE) carbon and nitrogen (δ^{13}C and δ^{15}N) stable isotope concentrations of taxa from the Crater Lake food web in 2008, 2009 and 2012 and the trophic position.

Taxa	**Common Name**	**Habitat**	**N**	**δ^{15}N (‰)**	**SE**	**δ^{13}C (‰)**	**SE**	**Littoral Benthic Reliance**	**Trophic Position**
Chironomidae	Midge	Eulittoral	12	-0.5	2.1	-6.9	2.8		--
Chironomidae	Midge	Sublittoral	28	2.6	0.23	-19	1.11		--
Chironomidae	Midge	Profundal	17	3.7	0.13	-27.3	0.25		--
Chironomidae	Midge	Whole Lake	57	2.2	0.3	-18.6	1.1		--
Oligochaeta	Worm	Eulittoral	3	1.5	0.5	-13.3	0.5		--
Oligochaeta	Worm	Sublittoral	5	2.8	0.5	-18.9	3.2		--
Oligochaeta	Worm	Produndal	2	5.1	0.7	-24	4.2		--
Oligochaeta	Worm	Whole Lake	10	2.9	0.5	-18.3	2		--
Trichoptera	Caddis	Eulittoral	13	3.4	0.7	-11	0.5		--
Gastropoda	Snail	Eulittoral	6	0.2	0.1	-5.8	0.3		--
Zooplankton*		Pelagic	7	-0.6	0.4	-31.2	0.3		--
Pacifastacus leniusculus	Signal Crayfish	Eulittoral	51	4.8	0.1	-8.5	0.4	97.4	--
Pacifastacus leniusculus	Signal Crayfish	Sublittoral	17	4.6	0.2	-10.6	0.4		--
Pacifastacus leniusculus	Signal Crayfish	Profundal	13	4.5	0.2	-11.8	0.7		--
Pacifastacus leniusculus	Signal Crayfish	Whole Lake	81	4.7	0.1	-9.4	0.3		2.9
Taricha granulosa mazamae	Newt	Sublittoral	21	5.54	0.2	-8.05	0.26	99.4	3.1
Oncorhynchus nerka	Kokanee	Pelagic	13	6.7	0.1	-24.9	1.1	27.0	3.0
Oncorhynchus mykiss	Rainbow Trout	Sublittoral	19	6.5	0.1	-10.7	0.7	88.0	3.4

*Pooled samples.

Table 1-3. Statistical coefficient summaries of logarithmic curves for stable isotope values $\delta^{13}C$ and $\delta^{15}N$ by depth; ANCOVA analysis of Chironomidae and crayfish by depth.

Source of Variation	**Sum of Squares**	**df**	**F- ratio**	***P* value**
ANCOVA analysis log depth				
$\delta^{13}C$	19.2	1	95.03	2.6 e-15
Factor (Species)	6.6	1	32.49	1.9e-7
ANCOVA analysis log depth				
$\delta^{15}N$	11.1	1	35.14	7.18 e-08
Factor (Species)	6.6	1	16.6	0.0001

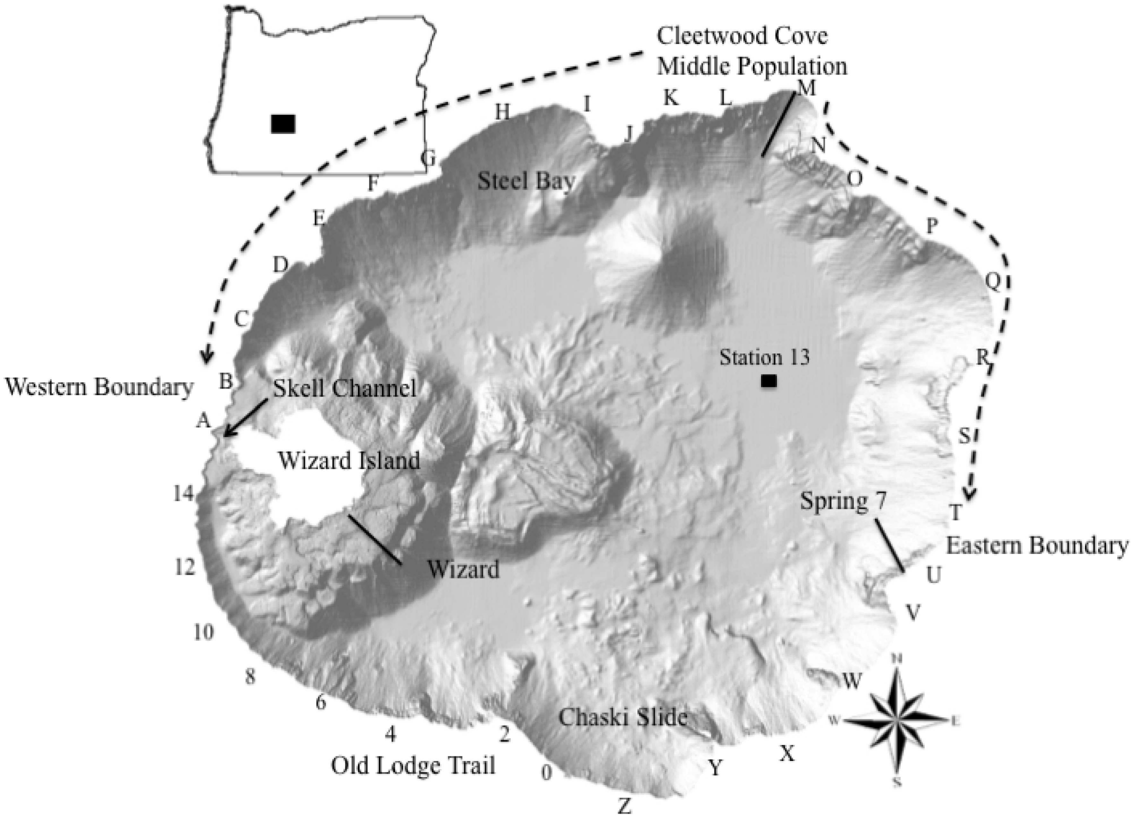

Figure 1-1. Bathymetric map of Crater Lake showing crayfish sampling sites. Solid lines indicate longline transect locations for crayfish traps. Only Cleetwood Cove was continued. Letters reflect nearshore crayfish sampling sites along the nearshore while W, before numbers, indicate nearshore locations around Wizard Island.

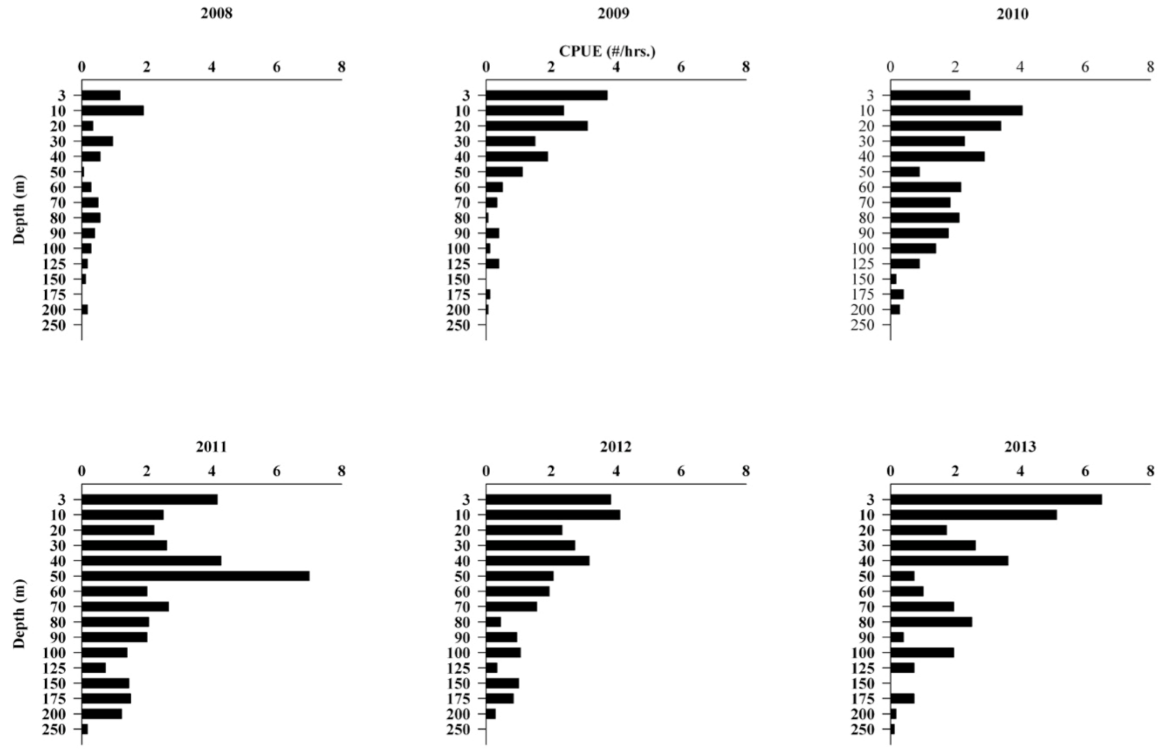

Figure 1-2. Crayfish densities (as measured by CPUE) from minnow traps along a depth gradient in September in Cleetwood Cove, Crater Lake 2008-2013.

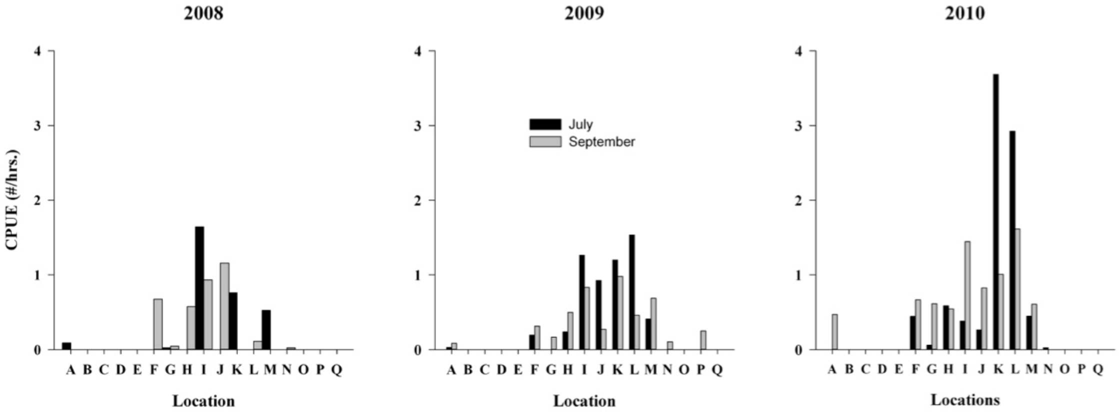

Figure 1-3. Minnow trap crayfish densities (as measured by CPUE) at nearshore sampling locations in Crater Lake in 2008, 2009, and 2010.

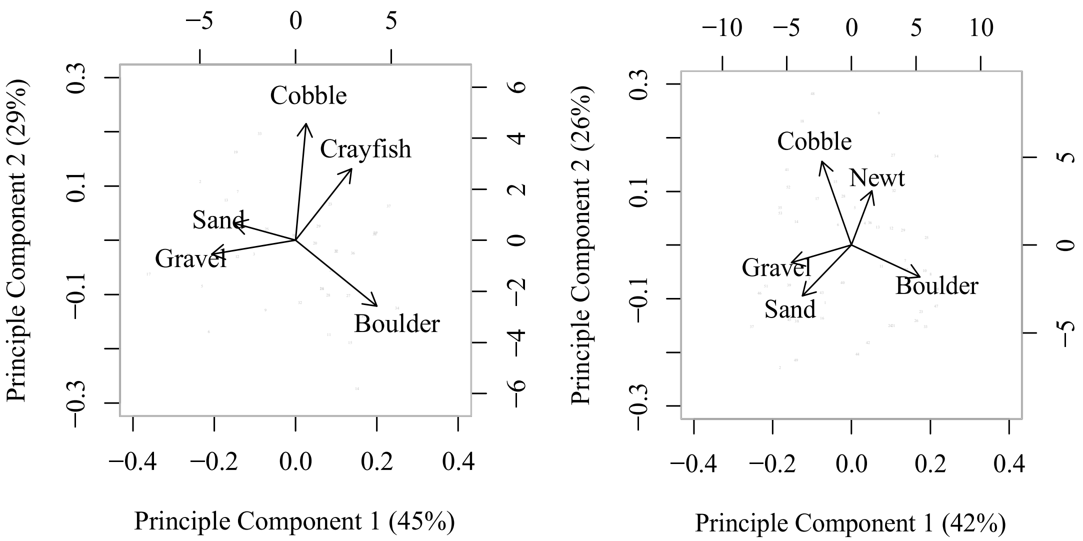

Figure 1-4. Principal components analysis with variation explained on axes to determine the habitat selection of a) crayfish and b) newt.

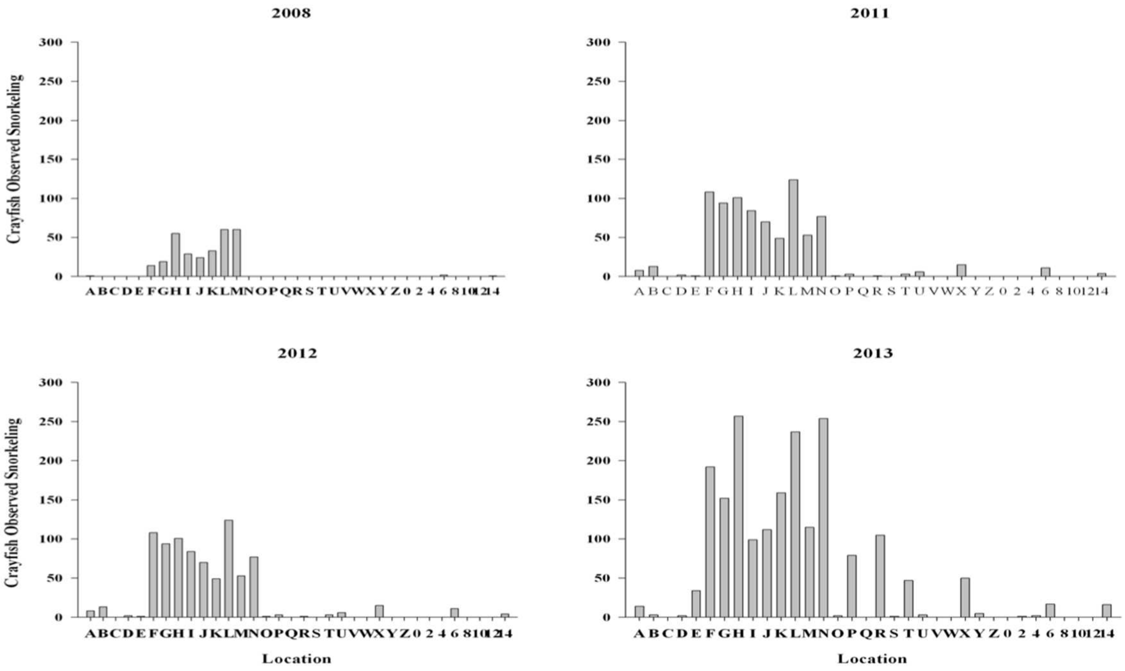

Figure 1-5. Crayfish densities determined by snorkeling around the nearshore during the summers of 2008, 2011, 2012, and 2013.

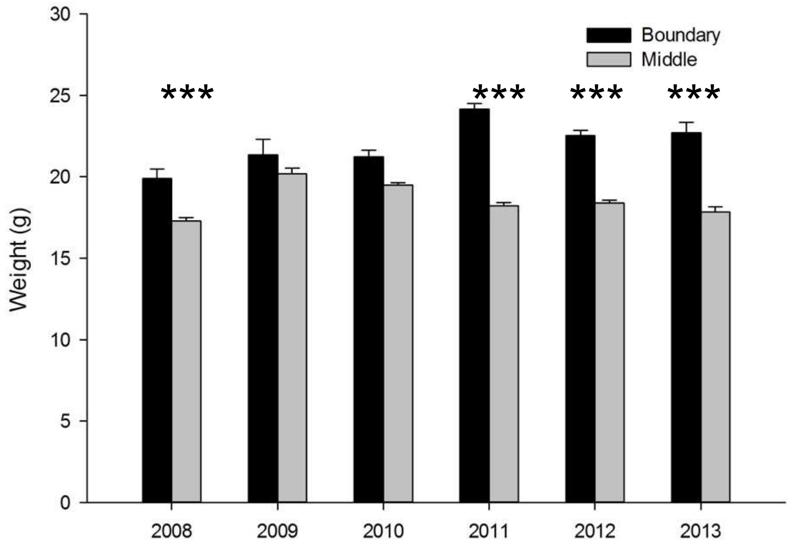

Figure 1-6. Mean weight for crayfish in Crater Lake at the middle (location L) of the Cleetwood Cove population and the boundaries of the nearshore population. *** Indicates pairwise comparisons within ANOVA were significantly different $P < 0.001$.

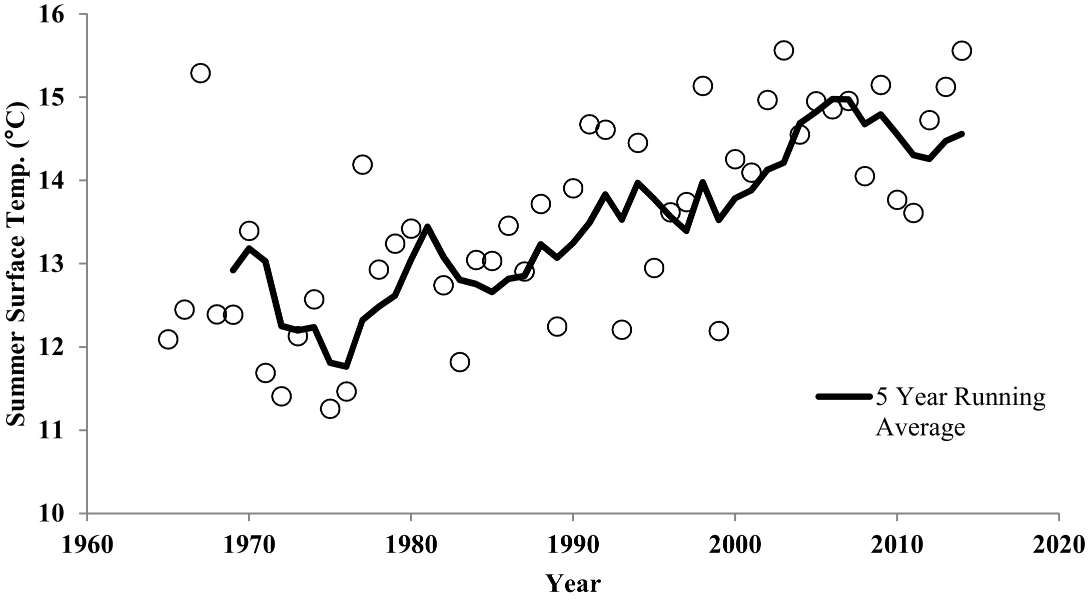

Figure 1-7. Crater Lake year round near –surface water temperatures collected at two locations between 1964 and 2003.

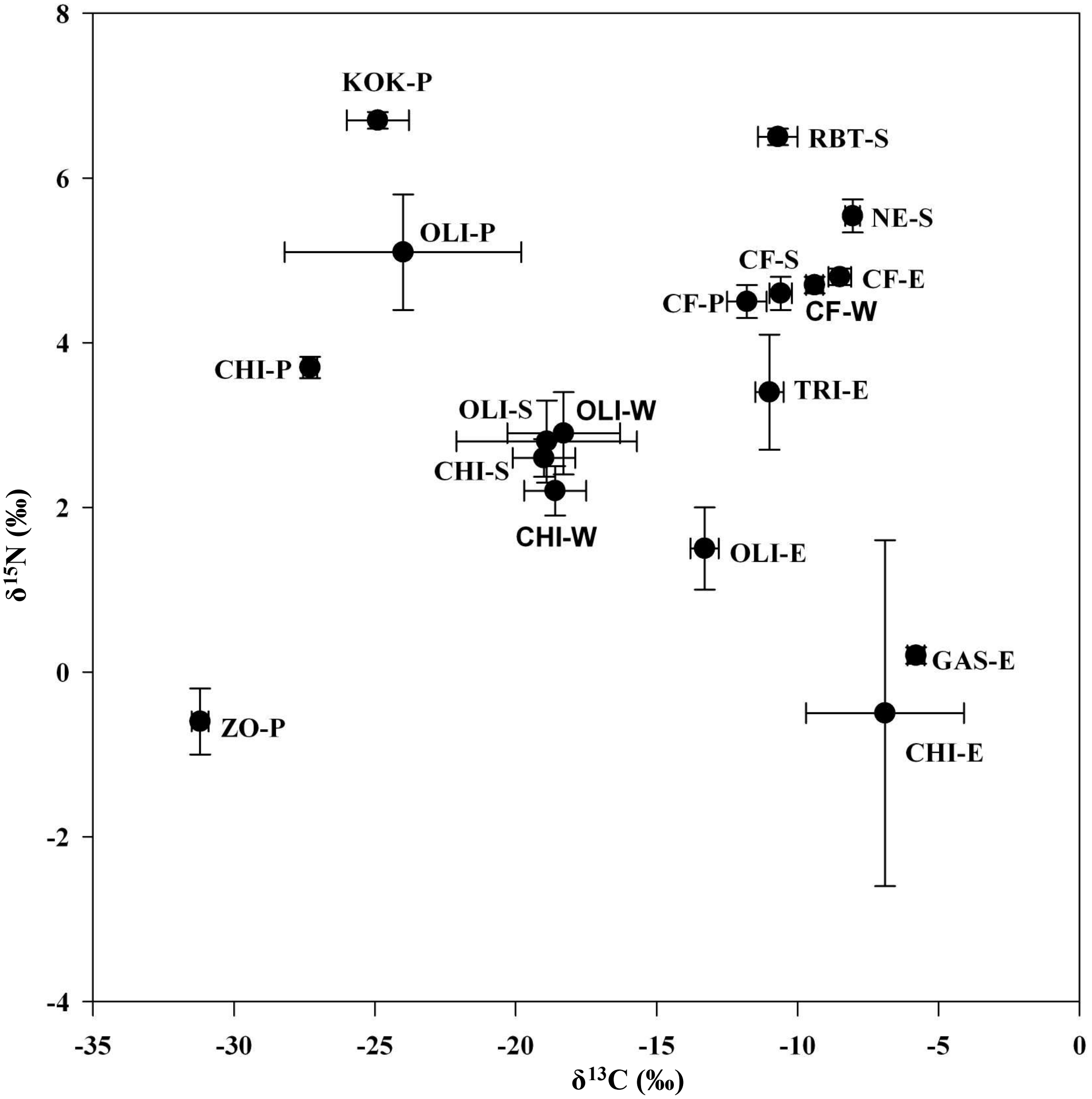

Figure 1-8. Stable isotope ($\delta^{13}C$ and $\delta^{15}N$) food web diagram for the major taxa of Crater Lake. Symbols are as follows: CHI-E, Chironomidae eulittoral; CHI-S, Chironomidae sublittoral; CHI-P, Chironomidae Profundal; CHI-W, Chironomidae whole lake; OLI-E, Oligochaeta eulittoral; OLI-S, Oligochaeta sublittoral; OLI-P, Oligochaeta profundal; OLI-W, Oligochaeta whole lake; TRI-E, Trichoptera eulittoral; ZO-P, Zooplankton pelagic; CF-E, Crayfish eulittoral; CF-S, Crayfish sublittoral; CF-P, Crayfish profundal; CF-W, Crayfish whole lake; NE-S, Newt sublittoral; KOK, Kokanee; RBT, rainbow trout.

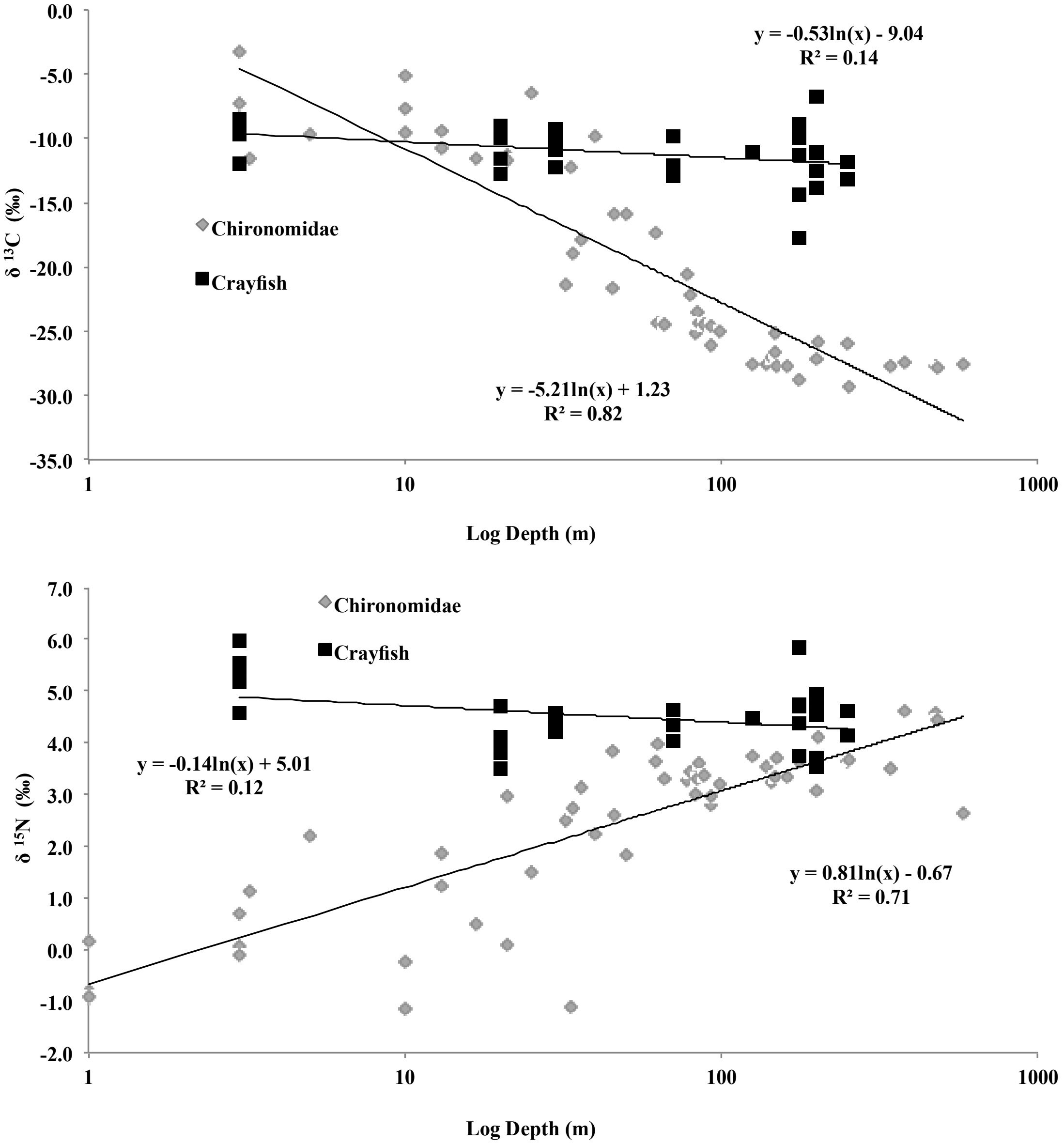

Figure 1- 9a and b. Stable isotope ($\delta^{13}C$ and $\delta^{15}N$) signatures of Chironomidae (black circles) and crayfish (grey diamonds) from a corresponding depth of capture. Chironomidae and crayfish were significantly different.

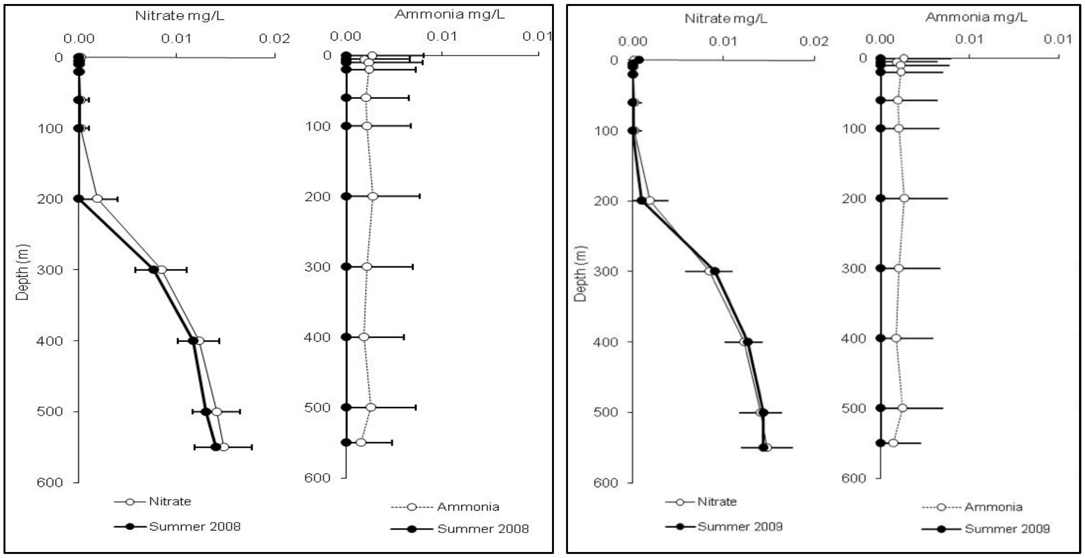

Figure 1-10. Nitrate and Ammonia concentrations (mg/L) by depth in Crater Lake during the summer in a) 2008 and b) 2009.

Chapter 2. The influence of nonative coldwater crayfish on the benthic ecology of an ultraoligotrophic lake

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Abstract

Invasive omnivores present unique problems for aquatic ecosystems by having both direct and indirect impacts on native benthic invertebrates and vertebrates. Invasive, omnivorous signal crayfish (*Pacifastacus leniusculus*) populations in Crater Lake, a large alpine lake in Oregon (USA), have been expanding in the littoral zone from 2008 to 2014. We quantify the influence of early, expanding invasion to littoral zone on benthic process, zoobenthic biomass and basal algal biomass. Benthic invertebrate biomass was 77% lower in hard substrate and 78% lower in soft substrate areas in crayfish-present locations than in crayfish-absent locations. Stable isotope mixing models suggest slight variation in crayfish diet at a location where crayfish have been established (e.g. Wizard Island), the outer boundary of crayfish expansion, and the middle of the crayfish population. In all three locations crayfish utilize Gastropoda despite limited detection of Gastropoda during sampling in crayfish present areas. At low crayfish densities (0 to 10) from total minnow trap catch, benthic invertebrate numbers were 222.3 ± 36.6 individuals m^{-2}, while chlorophyll *a* was 16.8 ± 5.8 $mg.m^{-2}$. At high densities of crayfish (>50), benthic invertebrates had low mean density 3.0 ± 4.2 individuals m^{-2}, while chlorophyll *a* biomass was high 226.7 ± 48.1 mg.m^{-2}. These data indicate that crayfish are impacting native invertebrate communities and periphyton biomass in Crater Lake by changing trophic interactions in the lake's littoral zone, altering the lake's food web and resulting in a possible trophic cascade.

Key Words: food web, signal crayfish, benthic invertebrates, trophic cascade

Introduction

The introduction of nonnative species is one of the main threats to freshwater ecosystem function, altering biodiversity, food web structure, nutrient dynamics, and production (Mack et al. 2000, Sala et al. 2000, Ricciardi et al. 2013). Introduction of invasive species in the littoral zone can impact these food web configurations. Understanding the dietary preference and impacts of an invasive omnivore can assist in our understanding of trophic configuration, and how changes in energy flow through a food web may change ecosystem functions (Menge 1995, Vander Zanden et al. 1999).

Omnivorous consumers, such as crayfish, govern zoobenthos composition and benthic algae production (Lodge et al. 1994, Moore et al. 2012; Twardochleb et al. 2013). Crayfish are potentially a model species for understanding the impacts of invasive species in freshwater ecosystems, as crayfish are one of the largest and longest-living macroinvertebrates in temperate freshwater environments, occur in high densities (Gherardi and Acquistapace 2007) and affect community structure and flow of energy in ecosystems (Flint and Goldman 1975, Lodge et al. 1994, Lodge and Lorman 1987). Crayfish can often occupy the highest trophic position normally filled by fish predators, influencing the production and composition of primary and secondary producers (Parkyn et al. 2001, Dorn and Wojdak 2004). For instance previous research by Moore et al. (2012) and Lodge et al. (1994) suggest that crayfish directly reduce zoobenthos and indirectly increase periphyton biomass.

Research has shown crayfish in eutrophic lakes and streams can reduce periphyton biomass, benthic fish communities, and biodiversity of benthic invertebrates (Light 2003; Lodge et al. 1994; Stenroth and Nystrom 2003; Nystrom et al. 1996; Twardochled et al. 2013). Despite extensive studies on the influence of crayfish in eutrophic lake ecosystems, few studies have investigated the dietary preference and impacts on food web structure and basal resources in oligotrophic lakes (for exceptions see Abrahamsson and Goldman 1970, Flint and Goldman 1975). Due to limited resources in unproductive lakes, crayfish can greatly surpass the functional role of smaller benthic invertebrates because of their biomass dominance and role as omnivores (Momot et al. 1978). Previous research on crayfish has shown differing dietary preferences, therefore, impacts on food web interactions and outcomes may change based on the species of crayfish, abundance, and the number of trophic interactions in the system (Larson and Olden 2010, Lodge et al. 2012, Matsuzaki et al. 2009). Consumers like crayfish are thought to be more carnivorous than herbivorous (Abrahamson 1965, Momot 1995); however, when benthic invertebrates are in low densities, crayfish consume large amounts of periphyton and macrophytes (Twardochleb et al., 2013, Lodge et al., 1994). This consumption in unproductive lakes may have larger effects on habitat configuration and trophic interactions than in other productive lakes, resulting in direct and indirect influences on a lake's benthic production (Abrahamsson 1965, Lodge and Lorman, 1987, Lodge et al., 1994).

Understanding impacts from invasive species and the factors governing littoral zone production and food web interactions has been a focus of numerous studies. Research suggests littoral regions are influenced by food web configuration and that these regions are a dominant contributor to whole ecosystem production and fisheries (Hecky and Hesslein 1995, Bootsma et al. 1996, Vander Zanden and Vadeboncoeur 2002, Vander Zanden et al. 2011). Crayfish predation may lead to the development of homogeneous benthic invertebrate communities over time as crayfish selectively feed on one or two common species (Lodge et al. 1994, Twardochled et al. 2013). Previous studies in Europe on populations of invasive signal crayfish have found that crayfish have direct impacts on benthic invertebrates, particularly Gastropoda in lake and stream ecosystems (Nystrom et al. 1996, Ruokenen et al. 2012, Ercoli et al. 2015). Gastropoda can exhibit behavioral avoidance to prevent predation (Nystrom and Perez 1998). Gastropoda are dominant grazers of periphyton and reduce periphyton biomass (Bronmark 1989, McCormick and Stevenson 1989). Feeding on Gastropoda could create a trophic cascade on the detrital base of the food web, as there would be a release on the grazing pressure on periphyton.

In this study we quantify the direct and indirect influences of an expanding population of invasive crayfish to native zoobenthic density and periphyton biomass. We predict that omnivorous crayfish will have a dietary preference for benthic invertebrates directly affecting density across soft and hard substrates reducing overall benthic invertebrate densities. Particularly, crayfish will disproportionately reduce Gastropoda abundance more than other benthic taxa. As a result of reductions in benthic invertebrate density will indirectly influence periphyton biomass due to a trophic cascade at differing (low to high) crayfish densities suggesting equal influences when crayfish are present in the littoral zone.

Methods and Study Area

Study System

Crater Lake, established as a National Park in 1902, is a deep, ultra-oligotrophic lake (mean summer Secchi depth of 30 m, 1883 m asl, z= 594 m; Larson and Buktenica 1996, Bacon et al. 2002). Due to the precipitously steep caldera walls and high slope gradients (50-140%), there are few beaches and the littoral zone is limited to relative lake volume (18.7 km^3). From 1888 to 1941, five species of salmonids (cutthroat trout, *Oncorhynchus clarki*; brown trout, *Salmo trutta*; rainbow and steelhead trout, *O. mykiss*; coho salmon, *O. kisutch*; and kokanee salmon, *O. nerka*), totaling nearly two million fish, were introduced into the naturally fishless lake (Buktenica and Larson1996). Only two species, kokanee salmon and rainbow trout, established self-sustaining populations (Buktenica and Larson 1996). Signal crayfish (*Pacifastacus leniusculus*) were introduced in the lake as a food source for the introduced fish in 1915 (Steel 1915). The crayfish are found in two general locations, Wizard Island and along the north shore centered on either side of Cleetwood Cove (sites K-O, Figure 2-1). Crayfish have expanded in both directions from the central population around Cleetwood Cove (Figure 2-1), while crayfish around Wizard Island have been confined to the upper 10 meters of the littoral zone. Crayfish increased from 44% nearshore occupancy in 2008 to 78% nearshore occupancy in 2014 (Umek et al. unpublished data).

Soft Substrate Sampling

Benthic invertebrates were collected in soft substrate habitats from one crayfish present (Cleetwood Cove) and one crayfish absent (Spring 7) location (Figure 2-1). At each site, samples were collected along a transect from 1 m to the maximum depth of 594 m, sampled at 5-25 m intervals to determine the composition and density of benthic invertebrates by depth in 2008 and 2009. Samples were collected using a Shipek grab sampler (area 0.039 m^2). Because habitats can be highly variable due to the heterogeneous nature of substrate in the littoral zone (i.e., plants, sediment, rock, organic matter), multiple grab samples were taken from each depth and location. Cleetwood Cove was sampled using 3 Shipek grabs combined at each depth, while only 2 Shipek grabs were combined during sampling along the Spring 7 transect. All benthic invertebrate samples were sieved through 500 um mesh, picked immediately, and stored in 70% ethanol. In the laboratory, Gastropoda and Oligochaeta samples were sorted to the class level, while Trichoptera were sorted to order. Chironomidae were identified to the species level for future analysis but pooled and analyzed at the family level (Supplemental Tables 1-1S).

Hard Substrate Sampling

Initial snorkel and trapping observations along the nearshore allowed us to identify locations with and without crayfish. From these initial snorkel observations we selected areas where crayfish were present or absent from hard substrate in the eulittoral zone (0 to 10 m). A mix of cobble and boulder substrate was chosen for each location as the preferred habitat of crayfish in Crater Lake. Hard sediment sampling was conducted with a lake vacuum, constructed from a submerged battery powered bilge pump connected to a mesh filter bag. Five locations were sampled using the lake vacuum; two locations where crayfish were absent (Spring 7 and Chaski Slide) located on the south side of the lake and three locations where crayfish were present (Cleetwood Cove, Steel Bay, and Wizard Island) (Figure 2-1). Collections were made at these sites during 2009, 2010, and 2011 to determine benthic invertebrate changes over time. At each location samples were collected from depths of 1, 3 and 10 m with two samples taken at each depth and pooled, using 1 x 1 m area quadrants set next to each other.

Benthic invertebrate samples from all soft and hard substrates were screened with a 500-µm mesh bucket and preserved in 70% ethanol. In the lab, invertebrates were separated from organic material and enumerated. We determined differences in benthic invertebrate populations between crayfish-present and crayfish-absent locations in both hard and soft substrate, and differences of Oligocheatea, Chironomidae, and total organisms abundance between Cleetwood Cove and Spring 7 transects with analysis of variance (ANOVA) and *post hoc* Tukey HSD tests. All analyses were conducted in Program R (version v3.0.2; R Development Core Team, Vienna, Austria) to compare between crayfish present and crayfish absent sites.

Crayfish Dietary Preference and Feeding Behavior

To characterize the food web dynamics, crayfish trophic position, and dietary preference we analyzed stable isotopes (carbon and nitrogen) from periphyton, benthic invertebrates (with a focus on primary consumers), and crayfish tail muscle tissue in 2008, 2009, and 2012. Stable isotope samples were dried at 60°C for at least 24 hours then ground into a fine powder by mortar and pestle. Samples were packed into tin capsules (8 x 5 mm) and analyzed for carbon using continuous flow isotope ratio mass spectrometry (IRMS) (20-20 mass spectrometer, PDZEuropa Scientific, Sandbach, United Kingdom). Sample combustion to CO_2 occurred at 1000 □C in an inline elemental analyzer (PDZEuropa Scientific, ANCA-GSL). The gases were separated on a Carbosieve G column (Supelco, Bellefonte, PA, USA) before introduction to the IRMS. These gases were compared to a standard gas (Pee Dee Belemnite) injected directly into the IRMS before and after the sample peaks. Isotopic ratio is expressed as a per mil (‰) deviation as presented in Chandra et al. 2005. Carbon and nitrogen isotopic ratios are expressed as a per mil (‰) deviation defined by the following equation:

$$\delta^{13}C \text{ or } \delta^{15}N = [(R_{sample}/R_{standard}) - 1] * 1000.$$

Thus, the more positive $\delta^{13}C$ is, the more isotopically enriched, or containing proportionally higher concentrations of heavier ^{13}C isotope, while ^{15}N can determine trophic position for within and among-system variation (Vander Zanden and Rasmussen 1999). We inferred crayfish diets with Bayesian stable isotope mixing models in Program R v3.0.2 (R Core Team 2013) using the package Stable Isotope Analysis (SIAR: Parnell et al. 2010). The Bayesian mixing model estimates probability distributions of source contributions to a mixture (Moore et al. 2008). The most common benthic invertebrates

(Chironomidae, Trichoptera, and Gastropoda) sampled in the eulittoral nearshore (0 to 10 m), were pooled and used as the source contributions to signal crayfish in the model (Table 2-1). As no signal crayfish specific fractionation corrections were available, we used fractionation values of 3.23‰ □ 0.41 for δ^{15}N and 0.47‰ □ 1.23 for δ^{13}C (Vander Zanden and Rasmussen 2001). Assimilation of periphyton material differs from animal tissue and therefore fractionation values of 2.4‰ □ 0.42 for δ^{15}N and 0.40‰ □ 0.28 for δ^{13}C were utilized (McCutchan et al 2003). Fractionation can vary depending on consumer characteristics, such as diet composition or feeding rates, and studies often assume constant fractionation rates and ignore the associated uncertainty (Vander Zanden and Rassumassen 2001). However, this model accounts for uncertainty associated with multiple sources, fractionation values, and isotope signatures (Moore et al. 2008). The median source contribution percentages are based on 50000 Markov chain Monte Carlo (MCMC) iterations to equilibrate the Markov chain on the dataset. To validate the mixing model we implemented a data cloning procedure, where data was replicated multiple times, to extract the Maximum Likelihood Estimates (Lele et al. 2007) and checked for estimability of the food sources used in the model (Lele et al. 2012).

Trophic interactions using natural observations

To determine whether there are minimum densities from which crayfish may influence periphyton biomass production by reducing benthic invertebrate densities, we sampled benthic invertebrates, and periphyton biomass (as indicated by chlorophyll *a*) on hard substrates at locations A, F, K, and N, low to high densities determined from total trap catch, in 2010. Two time periods (August and September) of primary productivity were sampled and data was pooled for statistical analysis (Figure 2-1). Periphyton was collected from natural rock substrates using a toothbrush and syringe sampler, and filtering a known fraction of the filtrate through 47 mm GF/F silica filters (Loeb 1981, Loeb and Goldman 1981). Filters were frozen and later extracted in methanol and the concentration of chlorophyll *a* was determined with fluorometry (Hauer and Lamberti 1996). Principal components analysis (PCA) was used to describe the relationship between crayfish density, benthic invertebrate density, and periphyton biomass in Program R (version v3.0.2; R Development Core Team, Vienna, Austria).

Results

Benthic invertebrate distribution

Soft substrate

The majority of benthic invertebrates caught in soft sediment transects consisted of oligochaetes and chironomids. Mean densities of oligochaetes and chironomids in soft sediment were significantly higher (ANOVA, $P < 0.0001$) at Spring 7, where crayfish were absent ($\bar{x}$=1325.6 ± 1743.0 and 1636.3 ± 792.9 m^{-2}, respectively), than at crayfish present locations at Cleetwood Cove ($\bar{x}$=91.4 ± 82.9 and 259.2 ± 254.6 m^{-2}, respectively; Figure 2-2). Oligochaete densities were high (5179 m^{-2}) at Spring 7 at 50-60 m depths, and then declined in density at 250 m to 256 individuals m^{-2}. Oligochaetes were recorded as deep as 580 m in Cleetwood Cove, but in relatively low densities (243 m^{-2}). Chironomidae density was more evenly distributed by depth, at approximately 2000 individuals' m^{-2} from 30-250 m deep in Spring 7 (Figure 2-2b). Five additional benthic invertebrate groups were identified at Cleetwood Cove (Ostracoda, Hyalella, Nematoda, Hemiptera, and Trichoptera), found sparsely between 25-145 m (Figure 2-3a). Nine additional benthic invertebrate groups were identified from Spring 7, with densities generally decreasing consistently from 15-165 m (Figure 2-3b). Gastropoda were only found in soft sediment at Spring 7, the only soft sediment location without crayfish during the sampling period (Figure 2-3b). In soft substrate areas the overall numbers were lower for both oligocheates (93%) and chironomids (84%) in crayfish-occupied areas compared to areas not occupied by crayfish.

Hard Substrate

At all 3 hard sampling depths (1, 3, and 10 m) benthic invertebrates in crayfish-present locations were 77% lower than in crayfish-absent locations and had a significant difference between crayfish-present and crayfish-absent depths (ANOVA F=58.41, P= 0.002; Figure 2-4). Benthic invertebrate abundance in hard substrate was highest (643 and 156 m^{-2}, respectively) at 1 m in both crayfish-present and crayfish-absent locations. In locations with crayfish present, hard substrate invertebrate abundance was slightly lower at 3 m and much lower at 10 m. In crayfish-absent locations, hard substrate invertebrate abundance also declined at 3 m (although still much higher than the same depth at locations with crayfish) and then increased again at 10 m. Samples from hard substrates, showed a greater number of benthic invertebrates in the crayfish-absent location (Spring 7), than in the crayfish-present location, (Cleetwood Cove) (ANOVA, F=14.06 P= 0.02; Figure 2-4). Gastropoda and Trichoptera were virtually absent in crayfish present locations by depth with the exception on 3 m (Figure 2-5).

The highest number of benthic invertebrates caught was in 2009 in crayfish absent locations. Between 2009 and 2011, the overall annual mean of benthic invertebrates sampled at crayfish locations decreased from 325 individuals m^{-2} to only 6 individuals m^{-2} (Figure 2-6). Invertebrate density was lower in both soft substrate (78% less) and hard substrate (77% less) in locations with crayfish compared to areas of the lake without crayfish.

Stable Isotope Analysis

Both soft and hard substrate sampling determined that the greatest number of benthic invertebrates were Oligochaeta, Chironomidae, Gastropoda, and Trichoptera. These benthic invertebrates from the eulittoral zone were pooled and used in mixing models to determine dietary preferences of crayfish (Table 2-1). In Cleetwood Cove, the location at the center of the crayfish population in Crater Lake, benthic invertebrates made up the majority of crayfish diet (96 % ± 0.9), while periphyton only made up the rest of the diet (0.04 % ± 0.01; Figure 2-6a). At the boundary where crayfish are expanding and densities are less, diets were dominated by benthic invertebrates (98% ± 0.95), while periphyton only accounted for a small fraction of crayfish diet (2% ± 0.03; Figure 2-6b). Similar to the boundary area, Wizard Island crayfish fed almost exclusively on benthic invertebrates (98% ± 0.96) with periphyton only accounting for a small fraction of crayfish diet (2% ± 0.03; Figure 2-6c). In all three locations (Cleetwood Cove, boundary, and Wizard Island) periphyton contributed little to crayfish diets.

The most important component of crayfish diet at Cleetwood Cove boundary, and Wizard Island was benthic invertebrates respectively. At Cleetwood Cove (60% ± 0.6) and Wizard Island (50% ± 0.45) Trichoptera accounted for the largest dietary proportion of crayfish (Supplemental Figure 1-1S). At the boundary area Gastropoda (55% ± 0.21) accounted for the largest crayfish dietary proportion (Supplemental Figure 1-1S) Data cloning results indicated an asymptotic relationship of the Maximum Likelihood Estimates for each of the crayfish food sources, which are invariant to the priors used indicating good model fit (Lele et al. 2012; Supplemental Table 1-2S).

Trophic interactions

In 2010, four hard substrate littoral locations (A, F, K, and N) were sampled for benthic invertebrates and periphyton at different crayfish densities in early August and late September, to determine crayfish impacts on benthic invertebrates and periphyton across the summer growing season. The first two axes of PCA explained 81% of the variation between crayfish, chlorophyll *a*, and benthic invertebrates (Figure 2-7). Crayfish had a positive relationship with chlorophyll *a* and a negative relationship with benthic invertebrates, particularly Chironomidae and Gastropoda (Figure 2-7).

A gradient of crayfish densities revealed different relationships between benthic invertebrates and periphyton between two-pooled sampling periods in August and September 2010 (Figure 2-8). In locations with 0 to 10 crayfish, benthic invertebrate mean densities were 222.3 ± 36.6 individuals m^{-2}, while chlorophyll *a* was lowest 16.8 ± 5.8 $mg.m^{-2}$. At crayfish densities 10 to 20, benthic invertebrate means decreased to 50.3 ± 11.3 individuals m^{-2}. At crayfish densities between 20 to 40, benthic invertebrate means decreased to 21.8 ± 7.8 individuals m^{-2}. At the highest crayfish densities (>50) benthic invertebrate numbers were lowest with 3.0 ± 4.24 individuals m^{-2} and chlorophyll *a* was highest with 226.7 ± 48.1 mg.m^{-2}. Similar to Gastropoda, only three Trichoptera were found during sampling at the highest crayfish densities (Table 2-2).

Discussion

Benthic invertebrates

Areas invaded by crayfish showed reduced invertebrate densities in both hard (77% less) and soft substrate (78% less). Our findings are consistent with previous research indicating that crayfish have strong, negative impacts on benthic invertebrate communities (Hanson et al. 1990, Nystrom and Perez 1998, Ruokonen et al. 2012, Twardochleb et al. 2013). At both soft substrate locations (Cleetwood Cove and Spring 7) invertebrate density increased below 10 m. The limitations of benthic invertebrates shallower then 10 m may be due to predation from fish, newts, crayfish (Cleetwood Cove only) or by eulittoral wave action, ultra-violet light, limited food resources or a combination of all factors, as shown in Lake Tahoe (Abrahamson and Goldman 1970). In the soft substrate at Cleetwood Cove, Chironomidae were present in greater numbers than oligochaetes. As found in other ecosystems, benthic invertebrate density and community composition was patchy between locations and depths, and differed substantially between the hard and soft substrates with a much higher diversity of benthic invertebrates in the hard substrates. Still, crayfish presence appears to be one of the main drivers for invertebrate density at all locations, as demonstrated by densities being highest at Spring 7, where crayfish were absent. Differences between invertebrate densities in soft sediment locations indicate that crayfish are potentially moving from cobble/boulder areas to soft sediment areas to forage at night.

Invertebrate density in hard substrate was highest at 1 m in both crayfish-present and crayfish-absent locations and decreased with depth. In locations with crayfish present, hard substrate invertebrate abundance was slightly lower at 3 m and much lower at 10 m. Therefore, the greatest difference in hard substrate and soft substrate benthic invertebrate densities between crayfish-present and crayfish-absent locations was at 10 m. Monitoring benthic invertebrate density and diversity at 10 m depth may be critical for assessing ongoing crayfish impacts on the benthos.

Between 2009 and 2011 the overall annual mean of benthic invertebrate density at crayfish locations decreased from 325 individuals m^{-2} to 6 individuals m^{-2} suggesting a strong negative influence on benthic invertebrate biomass by crayfish in a relatively short time frame. Changes in benthic invertebrate densities between years at crayfish-present and absent locations could represent short-term fluctuations over the summer resulting in interannual variability between years.

Dietary Preference

Data cloning results indicated an asymptotic relationship of the Maximum Likelihood Estimates for each of the benthic invertebrate sources used in the model, which are invariant to the prior source data used (although we had low sample sizes), suggesting that the prior source data had little influence on the parameter estimates (Lele et al. 2012; Supplemental Figure 1-1S). Our dietary models indicated that the most important component of crayfish diet in Crater Lake was Trichoptera followed by Gastropoda. This was surprising given that Chironomidae and Gastropoda had low densities in crayfish-present areas. Gastropoda were not found in the main areas of crayfish occupation during benthic invertebrate sampling of hard substrate suggesting that crayfish were highly selective on Gastropoda even when Gastropoda were at undetectable levels when sampling occurred. This is consistent with previous research by Ercoli et al. (2015) and Dorn and Wojdak (2004) that found predation impacts at lakes with abundant crayfish and low macrophyte biomass, as in Crater Lake, increased on invertebrates such as Gastropoda. In areas with high Gastropoda, concentrations of periphyton biomass were lower than in locations where Gastropoda were absent. Even in low crayfish density areas, predation was high enough to reduce benthic invertebrate densities compared to areas without crayfish.

Trophic Interactions

Although crayfish are thought to be more carnivorous than herbivorous, when benthic invertebrates are in low densities, crayfish consume large amounts of periphyton and macrophytes in eutrophic lakes (Lodge et al. 1994, Twardochleb et al. 2013). In Crater Lake, periphyton responded positively to the presence of crayfish at our sampling sites indicating indirect effects of crayfish in the littoral zone. We found strong negative effects on Gastropoda, Trichoptera and Chironomidae. Even in areas with low crayfish densities, Gastropoda were virtually absent (99%). Our study supports results from similar studies on other introduced crayfish. For example, Charlebois and Lamberti (1996) reported a decrease in benthic invertebrate density by 47-58%, while chlorophyll *a* increased by 48 – 70% in experimental studies on rusty crayfish (*Orconetes rusticus*), leading to trophic cascades in the nearshore.

Stable isotope analysis indicated direct predation by crayfish on benthic invertebrates while there was very little consumption of periphyton. However there was a small proportion of periphyton in crayfish diets at Cleetwood Cove, where there was the largest density of crayfish. This suggests that some crayfish may supplement their diet with periphyton, as sufficient invertebrate densities decline. PCA indicated a positive relationship with chlorophyll *a* and crayfish density, and a negative relationship between benthic invertebrates and crayfish. A reduction in benthic invertebrate densities allowed an increase in periphyton, thus indicating strong top down direct and indirect effects similar to other studies (Abrahamsson 1970; Lodge and Lorman 1987; Lodge et al. 1994; Bronmark and Weisner 1996). Trichoptera and Chironomidae were also favored by crayfish, likely due to ease of capture, high prey value, and low handling times similar to Gastropoda (Nystrom et al. 1998). While we expected to find a broader dietary preference for an omnivore crayfish, crayfish in Crater Lake were feeding mainly on invertebrates especially at varying crayfish densities around the nearshore similar to other research on signal crayfish (Ruokonen et al. 2012, Twardochleb et al. 2013, Ercoli et al. 2015). Crayfish in Crater Lake are directly and indirectly affecting the littoral zone at multiple trophic levels.

The findings provide 1) direct impact to benthic invertebrate densities and community composition due to crayfish, 2) indirect impacts on the periphyton community leading to trophic cascades and increasing food web connectivity, and 3) only slight differences in crayfish diets at varying crayfish densities across Crater Lake. Ecological effects may vary greatly among nonnative crayfish (Larson and Olden 2010, Lodge et al. 2013). Signal crayfish, however, are generalists that feed on native invertebrates and periphyton, and compete for resources with and habitat for fish and amphibians (Dorn and Mittelbach 1999; Ilheu et al. 2007; Twardochleb et al. 2013).

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Tables

Table 2-1. Stable isotope (δ13C and δ15N) mean and standard deviation results for various taxa collected from Crater Lake in 2008, 2009, and 2012.

Taxa	Habitat	N	δ^{15}N (‰)	SE	δ^{13}C (‰)	SE
Chironomidae	Eulittoral	12	-0.5	2.1	-6.9	2.8
Gastropoda	Eulittoral	6	0.2	0.1	-5.8	0.3
Trichoptera	Eulittoral	13	3.4	0.7	-11	0.5
Benthic Invertebrates	Eulittoral	31				
Pacifastacus leniusculus	Eulittoral	51	4.8	0.1	-8.5	0.4
Taricha granulosa mazamae	Eublittoral	21	5.54	0.2	-8.05	0.26
Periphyton	Eulittoral	7	-1.44	0.3	-24.2	9.8

Table 2-2. Descriptive statistics for two-pooled sampling time periods at differing crayfish densities for benthic invertebrates (mean individuals m^{-2}), and periphyton biomass (mg.m^{-2}) in Crater Lake in 2010.

Crayfish Density	Location	Total Invertebrates	Chironomidae	Oligochaeta	Gastropoda	Chlorophyll *a*
0 to 10	A	22.3 ± 36.6	28.3 ± 7.3	13.2 ± 11.3	122.7 ± 46.1	16.8 ± 5.8
10 to 20	F	50.3 ± 11.3	13.0 ± 4.8	12.0 ± 4.4	0	76.6 ± 5.6
20 to 40	K	21.8 ± 7.2	9.8 ± 3.4	6.8 ± 3.1	0	120.3 ± 13.1
>50	N	3.0 ± 4.2	2.5 ± 3.5	0 ± 0	0	226.7 ± 48.1

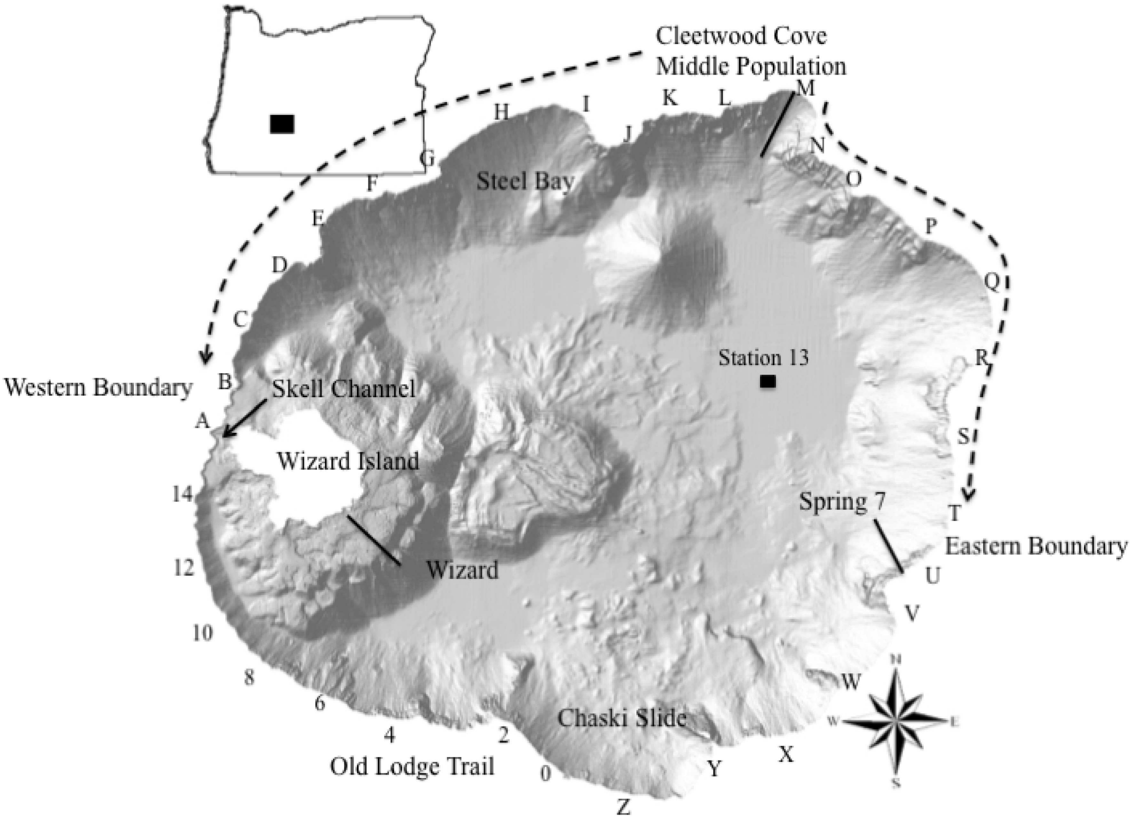

Figure 2-1. Bathymetric map of Crater Lake showing crayfish and benthic invertebrate sampling sites in the nearshore. Solid lines indicate transect locations where benthic invertebrate collections were conducted. Letters reflect nearshore crayfish sampling sites along the nearshore. Dashed arrow lines indicate the zone of expansion along the shoreline of Crater Lake.

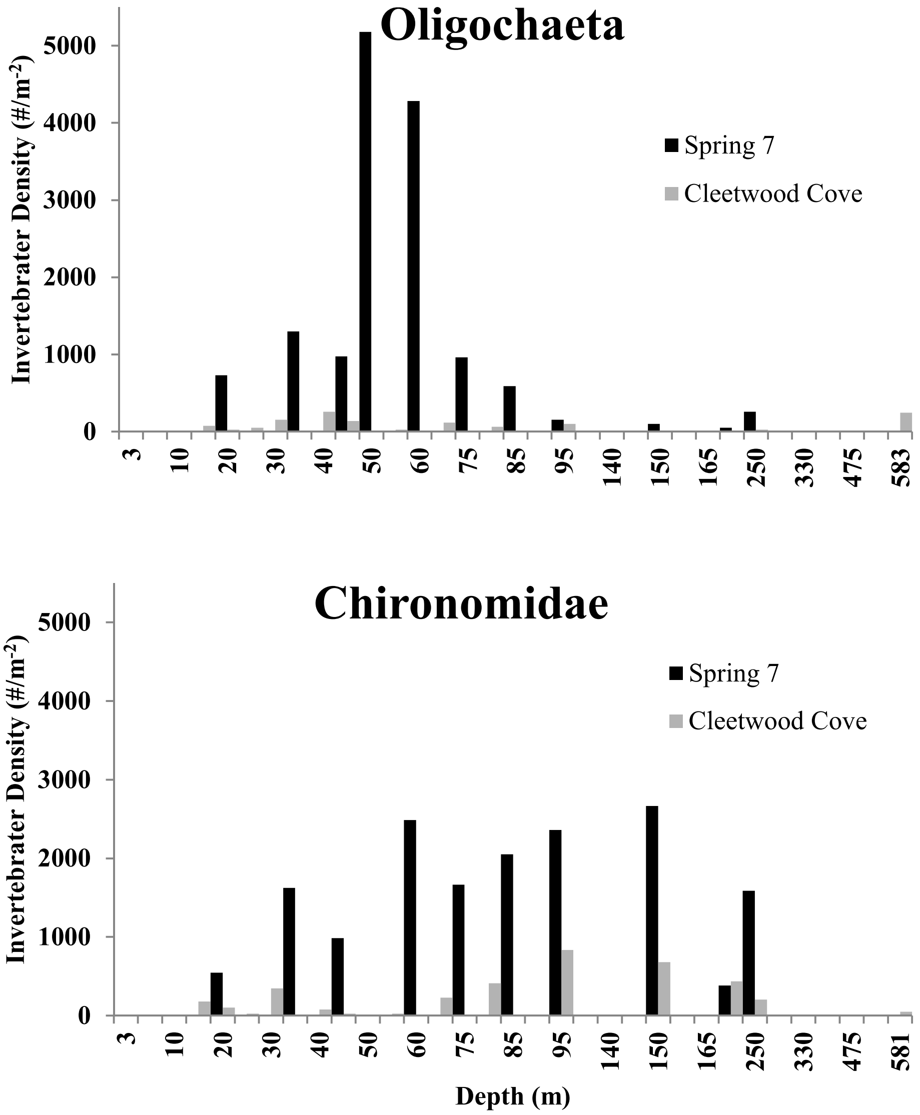

Figure 2-2. Oligochaete (top panel) and Chironomidae (bottom panel) distribution by depth in soft sediments at Spring 7 and Cleetwood Cove. Spring 7 had no crayfish, while crayfish were only found between 3 and 10 meters at Wizard Island.

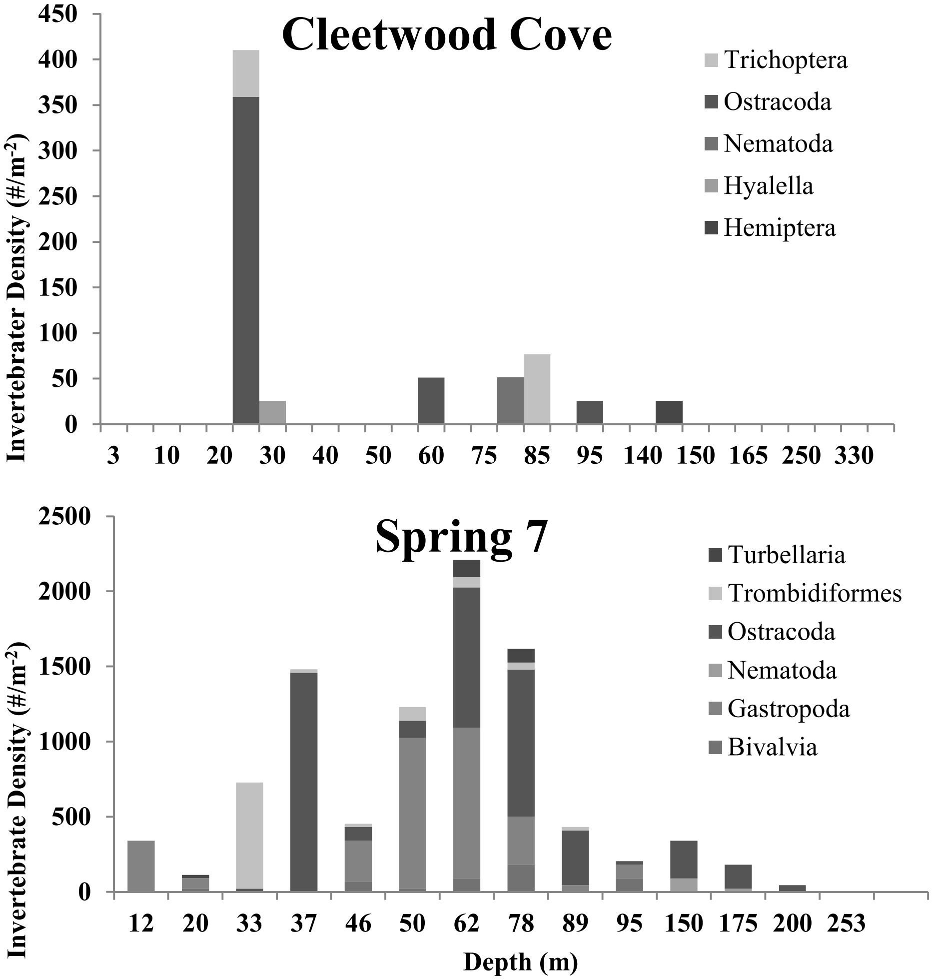

Figure 3. Depth distribution of benthic invertebrates caught at Cleetwood Cove, and Spring 7 in soft sediment. Please note different y-axes.

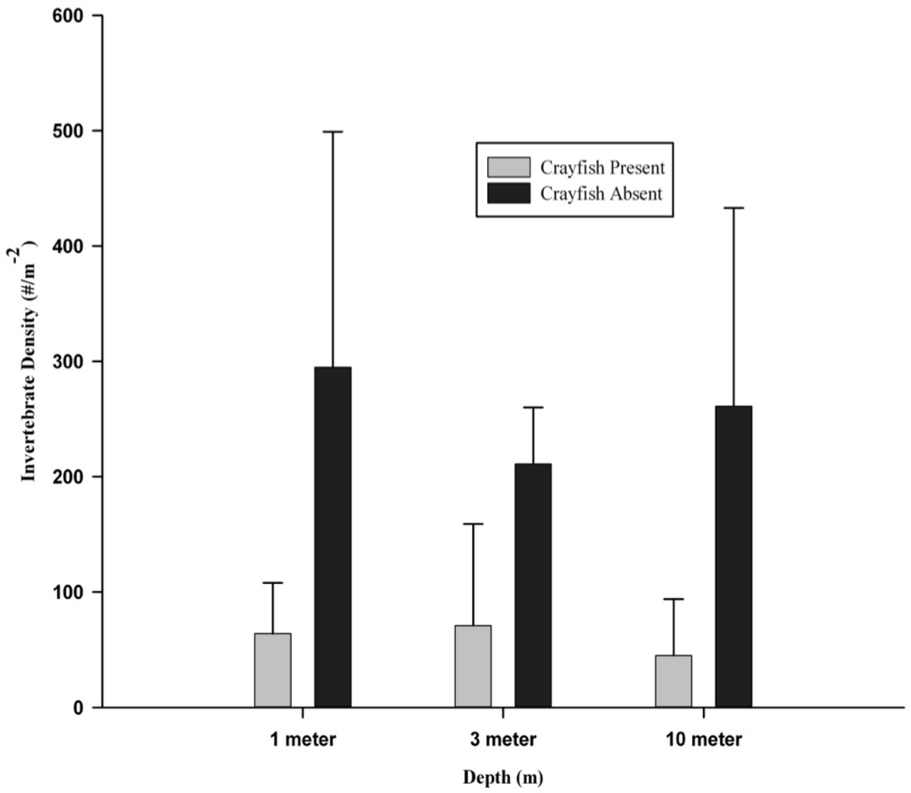

Figure 2-4. Density of benthic invertebrates at sites where crayfish were present (nearshore sites I and L) versus crayfish absent sites (nearshore sites T and X) in hard sediment at 1, 3, and 10 meters.

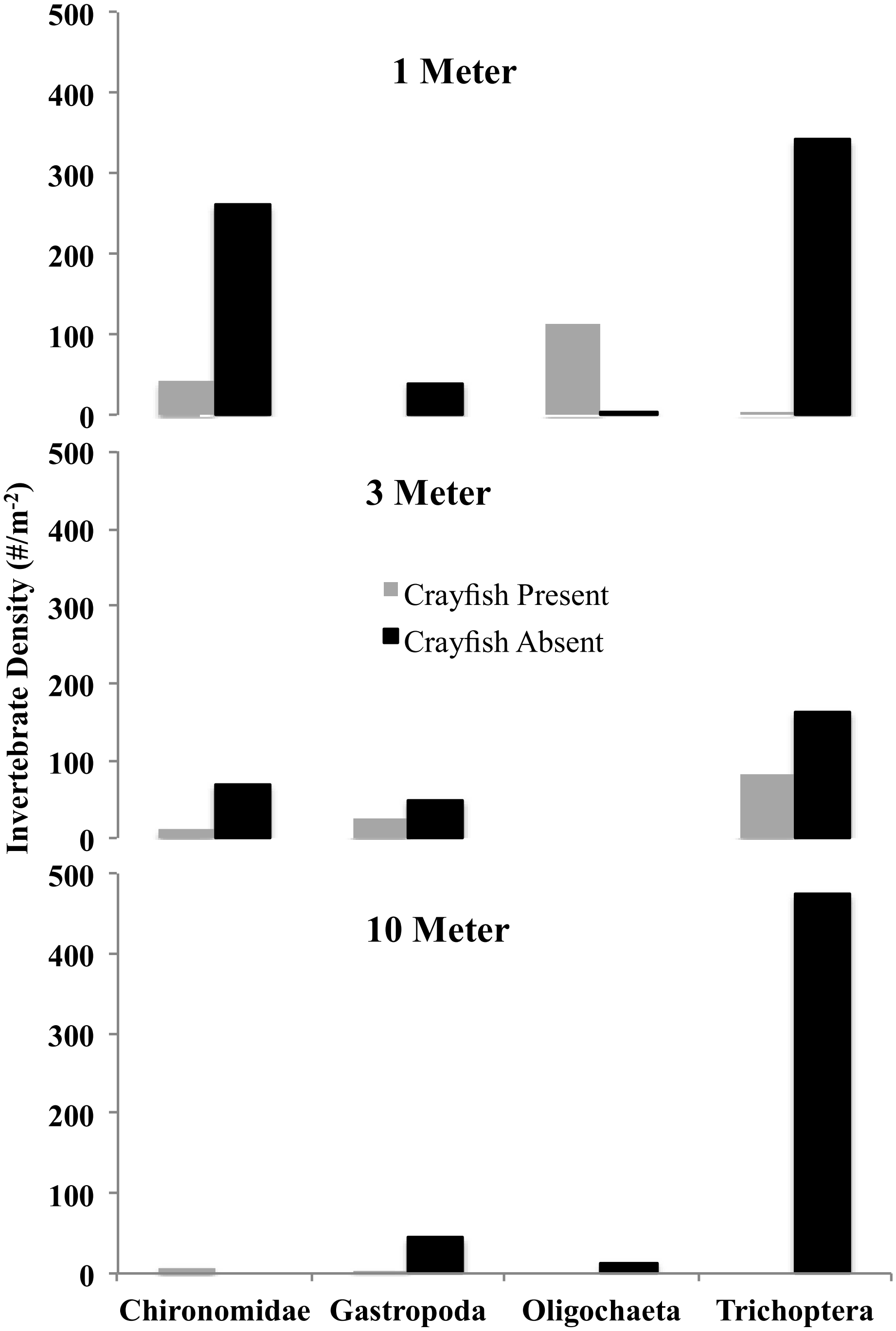

Figure 2-5. Density of Chironomidae, Gastropoda, Oligochaeta, and Trichoptera at sites where crayfish were present (nearshore sites I and L) versus crayfish absent sites (nearshore sites T and X) in hard sediment at 1, 3, and 10 meters.

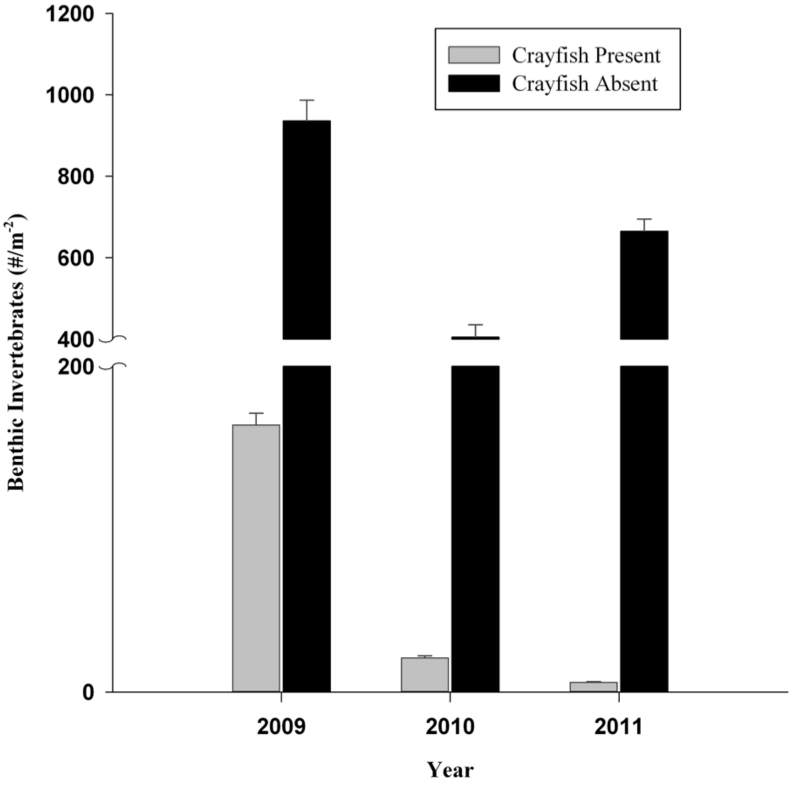

Figure 2-6. Total number of benthic invertebrates at crayfish present (black bars, n=2; nearshore sites I and L) versus crayfish absent sites (grey bars, nearshore sites T and X) between 2009 and 2010 in hard substrate.

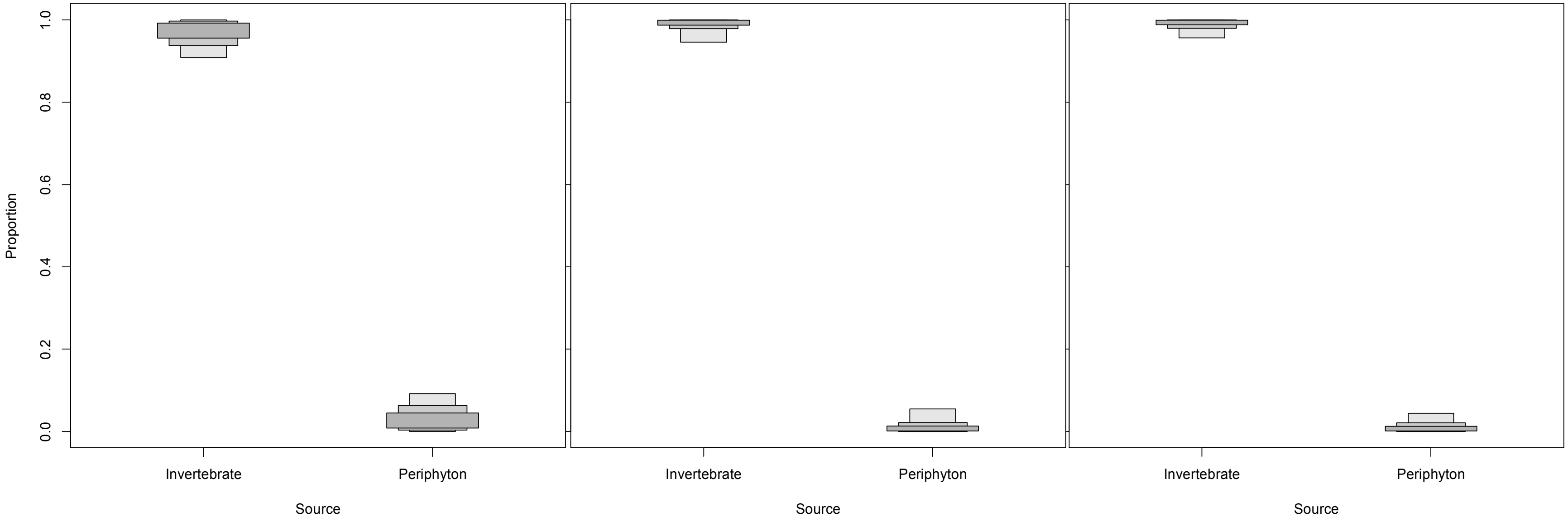

Figure 2-7. Dietary proportions for eulittoral food sources from a stable isotope Bayesian mixing model for crayfish at 3 locations: Cleetwood Cove, boundary of crayfish expansion, and Wizard Island. Boxes represent 50, 75, and 95% confidence intervals.

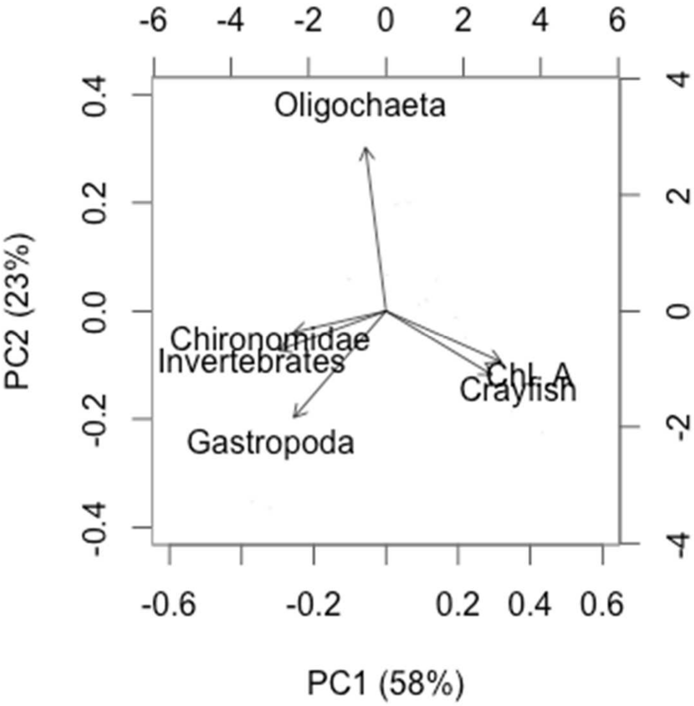

Figure 2-8. Principal components analysis with variation explained on the axes to determine relationships between crayfish, benthic invertebrates, and chlorophyll *a*.

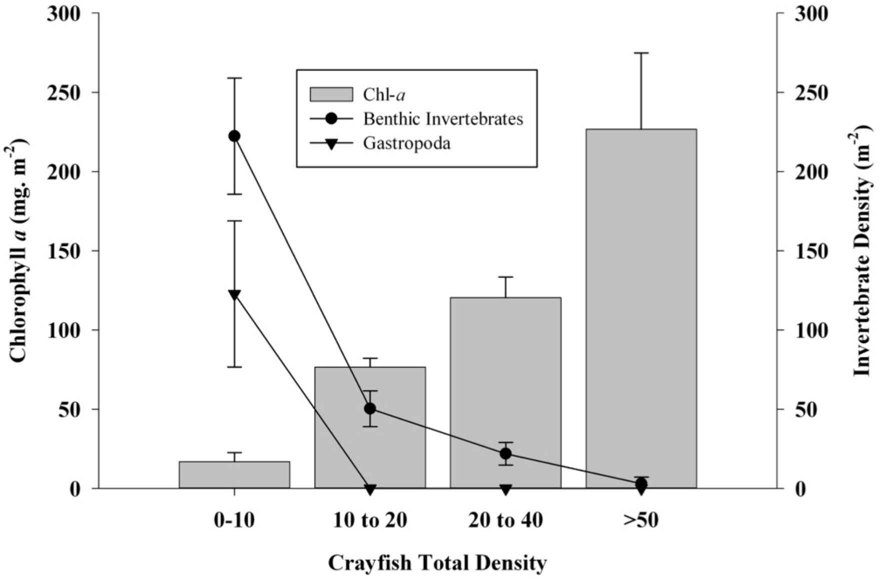

Figure 2-9. Chlorophyll *a* (mg.m^{-2}), total benthic invertebrates (m^{-2}), and Gastropda (m^{-2}) at 2 pooled time periods at differing crayfish densities.

Chapter 3. Ecology of invasive signal crayfish in large, oligotrophic lakes: seasonal movement, habitat preference and influence on native fish diet breadth

Abstract

The benthic environment and biodiversity in the Lake Tahoe Basin and surrounding area are changing due to the introduction of non-native species, particularly those that are capable of rapid spread and predation. Signal crayfish (*Pacifastacus leniscul*us) were introduced into the Central Sierra Nevada region of the United States in the late 19th to early 20th century. We document highly variable crayfish densities in the littoral zone in Lake Tahoe with an increase during the summer months linked to an increase in water temperature ($R^2 = 0.69$, $P<0.001$). Crayfish responded to site-specific characteristics of the nearshore rather than to lake-wide characteristics; local stream discharge was the only factor that explained a positive increase in lake densities ($P< 0.04$). Interpreting stable isotope trophic niche models developed for X lakes, we found that crayfish may influence the dietary breadth (e.g. niche area) of nongame fish consumers. For example, Tahoe sucker (*Catostomus tahoensis)*, an obligate benthic feeding fish, increased its niche area as crayfish densities increased. Crayfish feeding behavior may be forcing nongame fish to feed on a broader set of food resources when crayfish are present. Our study highlight that local factors influence cold-water crayfish movement and densities in large lakes, as well as potential direct and indirect influences on nongame fish consumers in the littoral region, potentially affecting native biota and ecosystem function.

Key Words: Introduced species, crayfish, stable isotope, niche area, benthic food webs

Introduction

The introduction of invasive species is one of the largest threats to aquatic ecosystems, influencing ecological processes at multiple trophic levels thereby leading to altered food web structures (Sala et al. 2000, Polis and Hurd 1996). Modifications to aquatic food web structure may result in species niche shifts and range from direct impacts on organisms, through both resource competition and predation, and via indirect changes via trophic cascades, where primary production increases due to a release in grazing pressure from other trophic feeding levels (Lodge et al. 1994, Charlebois and Lamberti 1996, Vitousek et al. 1996, Moore 2012).

Crayfish are an important organism in freshwater ecosystems. Because of their use as food and bait by humans, they are one of the most introduced species to aquatic ecosystems (Momot et al. 1978, Hobbs et al. 1989, Taylor et al. 2007, Gherardi and Holdich 1999). Annual crayfish production can exceed hundreds of kilograms per hectare, and biomass production and consumption often exceeds the production and consumption of all other benthic invertebrates combined (Momot 1995, Whitledge and Rabeni 1997). Once they invade, crayfish can dominate freshwater ecosystems having both direct and indirect effects on trophic interactions in aquatic systems (Lodge et al. 1994). In low nutrient lakes crayfish can greatly surpass their usual role as a consumer, because of their biomass dominance and functional role (Momot et al. 1978). Crayfish are dominant benthic consumers that deplete benthic invertebrate processes and biodiversity, periphyton biomass, and the abundance of benthic fish (Light 2003, Lodge et al. 1994, Stenroth and Nystrom 2003). When present, are widely recognized as a key component of benthic energy flow and nutrient cycling in aquatic systems (Lodge et al. 1994, Evans-White et al. 2001).

Due to the signal crayfish life span, up to 9-10 years (Huner 2002, Shimizu and Goldman 1983), they can have varying impacts on the ecosystem over time. In addition to life span, crayfish have large body sizes, frequent spawning, substantial annual egg production and low reproductive age, which allow them to tolerate adverse conditions, as well as spread to and colonize new areas (Abrahamson and Goldman 1970, Lewis and Horton 1997). During colonization, habitat type plays a major role in determining the type of organism that can inhabit an area (Nystrom et al. 2006, Ruokonen et al. 2012); previous research found habitat type to be a limiting factor governing crayfish densities (Nystrom et al. 2006, Lodge et al. 2000). Therefore, the size of crayfish populations may vary significantly between habitats within an ecosystem over short spatial scales (Abrahamsson and Goldman 1970, Guan and Wiles 1996, Kirjavainen and Westman 1999, Garvey et al. 2003), resulting in difficulty in predicting their specific influence on food webs within a large ecosystem.

Invasive species can also overlap with the trophic niche of native species, defined as the overall trophic role of that species, leading to direct competition for resources and habitat (Leibold 1995, Bergstrom and Mensinger 2009). Crayfish, benthic invertebrates, and benthic fishes all prefer similar habitats leading to interspecific competition for food and habitats (Blake and Hart 1993, Guan and Wiles 1997). The consequences of interspecific competition for habitat and food resources include reduced fish population densities and growth rates (Guan and Wiles 1998, Stenroth et al. 2006).

In addition to interspecific competition from introduced species, rising temperatures attributed to climate change may alter ecosystem phenology, food webs and species distributions, and the competitive dominance of one taxa over another (Beaugrand et al. 2002, Stachowicz et al. 2002, Perry et al. 2005, Grebmeier et al. 2006, Pörtner and Farrell 2008). Temperature regulates activity levels and reproduction stages in crayfish and are a major factor influencing timing and movement of crayfish (Bubb et al. 2004, Flint and Goldman 1975, Lozan 2000, Barbaresi and Gherardi 2001, Bubb et al. 2002). While lake warming can change the timing of peak primary production, on which fish and benthic invertebrate recruitment rely (Perry et al. 2003), it could also change the timing and movement of crayfish into the nearshore potentially increasing the interaction time of introduced crayfish with other taxa.

Signal crayfish (*Pacifastacus leniscululus*) were introduced in the western United States, in the late 19th century through the mid 20th century into the mountain ecosystems of the Sierra Nevada. Little research has focused on understanding the ecology and influence of these coldwater crayfish to limnetic ecosystems (for exception see Abrahamsson and Goldman 1965, Flint and Goldman 1975, Larson and Olden 2011). Most of the ecological studies from lake ecosystems were conducted in the 1960s to early 1980s. Subsequent to this period, lakes in the Western Region of the United States have warmed (Coats et al. 2006), which may alter the activity levels of the introduced crayfish including their migration and movement behavior, variation in density within an ecosystem over time, and foraging relationships and degree of interspecific competition.

In this paper, we summarize various data sets to understand 1) the distribution and interannual changes in density of signal crayfish from a longer-term data set in Lake Tahoe; 2) the environmental factors associated with crayfish densities over time (broad lake-wide variables such as diatom biomass, annual Secchi depth (m), annual average surface temperature (C°), annual average temperature (C°), lake stability, snow pack water equivalence for the Tahoe Basin Watershed, and Ward Creek stream discharge as a site specific variable); 3) influence of temperature on crayfish movement into the nearshore habitat; 4) habitat preferences of crayfish and nongame fish as an indication for potential competition; and 5) crayfish and nongame fish trophic position and niche total area as an indicator for potential competition. This is the first study to assess coldwater, signal crayfish distribution, abundance, and impacts at both local and landscape levels that may be meaningful to managers in the West.

Methods

Study locations

Coldwater signal crayfish were introduced into the Central Sierra Nevada region of the United States in the late 19th to early 20th century. The lakes in this region are typical, oligotrophic to ultra-oligotrophic lakes. In this study we used historical and existing data from four lakes (Table 3-1; Figure 3-1) to understand the ecology of cold-water crayfish and their potential influence in select lakes to native taxa. We utilized our data set to understand the interannual variability in crayfish, distribution and habitat utilization in space, and the environmental factors that influence the migration of crayfish.

For Lake Tahoe, crayfish and nongame fish were collected at monthly intervals (July, August, and September) between 2008 and 2009 along transects using minnow traps set at 14 locations around the lake at 6 depths in the littoral zone for at least a 12 hr period. Density is estimated using catch per unit effort (CPUE) for crayfish and nongame fish caught in baited minnow traps. Between 2010 and 2014, 6 depth transects were sampled around the lake. At each location, two traps were utilized in case of trap loss and placed overnight at discrete depths (3, 5, 10, 20, 30, 40, 50 m). For all traps, fish were identified and counted and crayfish were counted and gender determined. For some locations and time periods crayfish carapace length and tail muscle samples were also collected for stable isotope analysis. Our data on crayfish and nongame fish were compared to historical crayfish information collected during the late 1960s (Abrahamsson and Goldman 1970), 1970s (Flint and Goldman 1975) and 1990s (Chandra unpublished data) and nongame fish data from the early 1990s (Allen and Reuter 1996) to determine ecological changes (e.g. density, defined as CPUE) over time at Sunnyside, on the north side of Lake Tahoe (Figure 3-1).

To classify substrate, habitat preference and determine presence or absence of crayfish and nongame fish in conjunction with minnow trapping in Lake Tahoe, snorkel surveys were performed in 2009. Beauchamp et al. (1991), previously estimated fish biomass at 37 locations. In 2009, we snorkeled a total of 49 sites, equally spaced around the lake, to determine differences in fish biomass between time periods (Figure 3-2). Two snorkelers swam for 10 minutes at 1 and 3 m depths to classify substrate based on the Wolman Pebble Count (Wolman 1954) and count the number of nongame fish and crayfish.

Data Sources affecting crayfish movement and densities

To determine the influence of temperature on crayfish movement into the nearshore of Lake Tahoe, minnow traps were set once a month for a year in 2012. I-button thermistors (Embedded Data Systems) at 2 transect locations recorded epilimnetic temperature eight times daily; a weekly average temperature was calculated to correspond with crayfish sampling. To determine temperatures below 10 meters, offshore temperatures were measured with mercury Reversing Thermometers (RTs), collected by UC Davis as part of the REMOTE program. Since lake gradient may have an impact on crayfish movement, two transect locations with differing nearshore slopes were chosen in Lake Tahoe (Crystal Bay- a steep gradient; Sand Harbor- a gradual gradient).

Multiple biotic and abiotic environmental factors influence the densities of organisms in freshwater ecosystems across spatial scales. Lake Tahoe has long-term water quality monitoring program that provides an ideal system to determine factors influencing crayfish densities over time (Jackson et al. 2001). We analyzed five lake-wide parameters (diatom biomass, annual Secchi depth (m), annual average surface temperature (C°), annual average temperature (C°), and lake stability) and two site-specific variables (Ward Creek stream discharge and snow water equivalence -SWE) to determine what factors might influence crayfish densities in Lake Tahoe on a spatial scale. Multiple linear regression was utilized to determine parameters affecting crayfish densities in Lake Tahoe in late summer at one location (Sunnyside), as it has the longest historical record of crayfish densities (1991-1994, 2000, 2008-2014). Cluster analysis utilizing the “kmeans” object was also utilized to look at the number of clusters between factors influencing crayfish density and correlations between those lake variables using

Program R v3.0.2 (R Core Team 2013). We developed a best-fit polynomial linear or polynomial regression model of crayfish CPUE and lake variables.

Trophic Interactions and Niche Overlap from Lakes with Differing Crayfish Densities

To understand the influence of crayfish on nongame fish consumers, we sampled multiple lakes with varying crayfish densities and nongame fish composition (Table 3-1). Data were collected in 1998 and 2008 on a range of taxa from Lake Tahoe and four surrounding lakes in the watershed with differing crayfish densities. Nongame fish in each lake were collected using minnow traps deployed during the summer of 2010 and 2011 along 4 depths (1, 5, 8m) in the lakes. Fish catch was identified to species. Dorsal muscle tissue was collected from a subset of each species per collection and analyzed for natural abundance of stable isotope (carbon and nitrogen) to quantify trophic niche area. Nongame fish composition is similar between lakes with the notable exception of Lake Trout (*Salvelinus namaycush*), which are only found in Lake Tahoe (including Emerald Bay) Fallen Leaf Lake, and Donner Lake (Supplemental Table 1-5S).

To assess food web relationships, particularly resource overlap, and the proportion of benthically- versus pelagically-derived energy in crayfish and nongame fish diets, we analyzed stable isotopes of carbon and nitrogen. Isotopic δ^{13}C has been used frequently to determine the flow of organic matter through food webs (Gu et al. 1994, Kling 1994, Vander Zanden and Rasmussen 1999). The minimal enrichment (± 0.47‰) in $\delta\,^{13}$C from lower to high trophic levels allows for distinction between benthic-littoral and pelagic primary production sources in the tissues of consumers (Hecky and Hesslein 1995, Vander Zanden and Rasmussen 2001). Ratios of ^{15}N and ^{14}N (expressed as δ^{15}N) display enrichments with trophic transfers and therefore used to estimate trophic position.

Trophic position was determined using $\delta^{15}N$ to standardize for within and among system variation at the base of the food web:

$$(1)\ TP_{consumer} = ((\delta^{15}N_{consumer} - \delta^{15}N_{primary\ consumer})/3.4) + 2,$$

where 3.4 is the per trophic level enrichment in $\delta^{15}N$ (Vander Zanden and Rasmussen 2001). The lowest primary producer was utilized for $\delta^{15}N_{primary\ consumer}$ in each system.

Samples of each fish taxa and crayfish were dried at 60°C for at least 24 hours then ground into a fine powder by mortar and pestle. The samples were packed into tin capsules (8 x 5 mm) and analyzed for carbon using continuous-flow Isotope Ratio Mass Spectrometry (IRMS) (20-20 mass spectrometer, PDZEuropa Scientific, Sandbach, United Kingdom). Sample combustion to CO_2 occurred at 1000° C in an inline elemental analyzer (PDZEuropa Scientific, ANCA-GSL). The gases were separated on a Carbosieve G column (Supelco, Bellefonte, PA, USA) before introduction to the IRMS. These gases were compared to a standard gas (Pee Dee Belemnite for carbon, atmospheric air for nitrogen) injected directly into the IRMS before and after the sample peaks. Isotopic ratio is expressed as a per mil (‰) deviation from the standard gas, defined by the following equation: $\delta^{13}X = [(^{13}X/^{12}X)_{sample} / (^{13}X/^{12}X)_{standard} - 1] * 1000$, where X is the element (in this case, C or N). Thus, a more positive $\delta^{13}C$ value indicates an isotopically enriched sample, containing proportionally higher concentrations of the heavier ^{13}C isotope, than a sample with a less positive (depleted) $\delta^{13}C$ value.

Statistical Analysis

Density was measured as catch per unit effort (CPUE), as determined from the number of crayfish and benthic fish caught in each trap divided by the number of hours of soak time for each trap. To determine the best fit polynomial regression models of crayfish CPUE and temperature, we used a model comparison approach where AIC (Akaike Information Criterion) was utilized as a metric of model support (Brunham and Anderson 2002). To determine size classes of crayfish, carapace lengths were taken at the Sunnyside location. To account for large data sets and determine crayfish size classes we utilized cluster analysis using the "clara" function in Program R (Kaufman and Rousseeuw 1990). The mean of the dissimilarities of the observations of their closest medoid was used as a measure of the quality of the clustering. The average silhouette width was used to determine the best number of size classes.

We used Principal Components Analysis (PCA) to describe the relationships between the crayfish and nongame fish composition and the underlying environmental gradients (substrate type) that influence the structure of the crayfish and nongame fish community in Program R (version 2.11.1; R Development Core Team, Vienna, Austria).

Variations in stable isotope values are commonly used to measure the width of trophic feeding niches or assess differences in food web structures (Layman et al. 2007, Olsson et al. 2009). We analyzed crayfish and nongame fish from Lake Tahoe during two different time periods (1998 and 2008) to determine changes in isotopic trophic niche widths overtime and at differing crayfish densities. To determine niche areas of crayfish and nongame fish at varying densities, isotopic analysis was utilized on samples collected at two locations in Lake Tahoe, Emerald Bay and Sunnyside, and from three lakes

(Donner Lake, Fallen Leak Lake, and Marlette Lake) in the Eastern Sierra Nevada region with differing nongame and game fish compositions. Isotopic trophic niche widths (total area, TA) were determined using $\delta^{15}N$ and $\delta^{13}C$ values and encompassed by the smallest convex polygon (Standard Ellipse Area corrected SEAc), containing the individuals from each site in trophic space (Layman et al. 2007). Convex polygons were calculated using SIBER (Stable Isotope Bayesian Ellipses in R) using a Bayesian approach that accounts for small sample size and accounts for natural error in the sampling process in Program R (Jackson et al. 2011). The distributions of polygons are based on multivariate normal distributions. In this case, bivariate dimensions and the ellipses are unbiased with respect to sample size and are estimated via Bayesian inference, which allows for comparing different sample sizes (Jackson et al. 2011).

Results

CPUE, distribution, and seasonal variation in Lake Tahoe

Of the 14 transects sampled between 2008-2010 the highest nearshore densities occurred at the north end of the lake (Figure 3-3). The highest densities of crayfish in the nearshore of Lake Tahoe in 2008 and 2009 were at Tahoe City and Crystal Bay (Figure 3-3). Crayfish CPUE increased in the nearshore during the summer months, then decreased by depth in the fall (Figure 3-3). Total crayfish catch at Sunnyside between 2008 and 2014 in late summer (August/September) was fairly consistent, but lower compared to the other transects around Lake Tahoe (Supplemental Figure 1-4S). In 2013 all crayfish decreased with the exception of Sunnyside (Figure 3-4). At depth, crayfish CPUE increased later in the summer and then decreased in the fall, as lake temperature began to drop (Figure 3-3 and 3-4). Total crayfish numbers at the Sunnyside location in

Lake Tahoe varied between 1967 and 2015 (Figure 3-5). Total crayfish numbers were highest in 2009 and 2010 but dropped precipitously during 2011; overall, the lowest total numbers were observed in 1991 (Figure 3-5).

A total of 1350 crayfish were measured for carapace length at the Sunnyside and Crystal Bay locations to determine size classes in Lake Tahoe. The mean length of crayfish was 40.0 mm and the weight was 14.9 g (Supplemental Table 1-3S). Females at Crystal Bay were the dominant catch in January, February, April, October, and November (Supplemental Figure 1-4S). Males dominated transect catch at Sand Harbor from January to May and in November and December in 2012 (Supplemental Figure 1-4S). Between May and October, the gender of crayfish captured in traps was even. Lake Tahoe had nine size classes determined by the estimation of average silhouettes (0.63) from carapace length indicating reasonable structure for the size classes (Supplemental Figure 1-5S).

Factors Influencing Crayfish Density and Movement

At both Crystal Bay and Sand Harbor locations crayfish densities were associated with temperature ($y = 7.99x + 6.64$ $R^2 = 0.76$; $y = 7.99x + 6.30$ $R^2 = 0.81$ respectively; Figure 3-6). Once temperature began to rise above 4°C crayfish increased in the nearshore at both locations (Figure 3-6). At Crystal Bay crayfish numbers increased with the increase in temperature with only a slight lag time. July and August had the highest temperature and August had the largest number of crayfish in the nearshore at Crystal Bay with the lowest concentrations occurring in March associated with the lowest nearshore temperature. Sand Harbor had a lag time of about a month before crayfish numbers increased in the nearshore. Crayfish CPUE in the nearshore had a strong relationship with temperature (Temperature = 4.983 + 16.447 x – $8.354x^2 + 3.864x^3 – 1.027x^4$, $R^2 = 0.72$, $P < 0.003$; Figure 3-7, Supplemental Table 1-4S).

Ward Creek discharge was the only parameter that had a significant relationship with crayfish CPUE ($P< 0.04$) and was selected as the best model (Table 3-2; ΔAIC 23.93). The model containing all the factors utilized in this study that may influence crayfish density was the least selected model (ΔAIC 29.76; Table 3-2). Correlation analysis revealed 4 clusters between the lake factors (Figure 3-8). Cluster analysis associated crayfish CPUE and discharge similar to our regression models (Figure 3-8).

Habitat preference at Lake Tahoe

Overall, substrate observed during snorkeling surveys at Lake Tahoe consisted mainly of boulder (40%), sand (33%) and cobble (25%); gravel accounted for only 2% (Supplemental Figure 1-5S). A majority of South Lake Tahoe consisted of sand, mainly from the inflow of the Upper Truckee River. PCA was significant (first two axes explained 59% and 51% of the variation respectively) between crayfish and nongame fish substrate occupation (Figure 3-9a). Crayfish numbers were positively related to areas with gravel and cobble. Lahontan speckled dace numbers were also strongly associated with gravel and cobble, while Tahoe suckers and Lahontan redside shiners were associated with areas with boulders (Figure 3-9b).

Nongame Fish

The most common species caught in minnow traps and observed while snorkeling were Lahontan reside shiners and Lahontan speckled dace. The highest densities of nearshore fish were observed at 1 m depths and at sites containing boulder with either cobble or sand. For both juveniles and adults, Lahontan redsides were mainly associated with boulder substrates. A majority of fish caught between 2008 and 2012 were caught between 3 and 10 meters, while Tahoe suckers and Tui chub were caught at deeper depths. Nongame fish densities decreased in the nearshore at all locations between 1991 and 2012 (Figure 3-10). Sunnyside had the lowest nongame fish captured between 1991 and 2012. At Crystal Bay (North Stateline) and Sunnyside no fish were captured during the summer months in 2012. Between 1991 and 2012 there was a 94% decrease in total catch at Sugar Pine Point.

Niche Overlap of Consumers Signal crayfish and Forage Fishes

Crayfish total minnow trap numbers in the nearshore varied between lakes within the region. Lake Tahoe had the largest nearshore crayfish in the nearshore (66) followed closely by Donner Lake (58), and Fallen Leaf Lake (26) had the lowest crayfish numbers (Figure 3-11). Emerald Bay, a small basin within Lake Tahoe, had crayfish numbers (26) slightly above Fallen Leaf Lake. Marlette Lake had average crayfish numbers (49). Trophic position (TP) varied between lakes (Table 3-3). Fallen Leaf Lake crayfish had the lowest TP (2.02 ± 0.07) while Marlette crayfish had the highest TP (5.14 ± 0.03; Table 3-3).

Isotopic δ^{13}C values for crayfish in Lake Tahoe in 1998 and 2008 ranged from -15.67 ± 0.49 to -17.56 ± 02 while δ^{15}N values ranged from 4.23 ± 0.13 to 4.66 ± 0.07. No overlap occurred between crayfish and nongame fish in 1998 (Figure 3-12). However, in 2008, crayfish overlapped with Tui chub (48%) and only slightly with the Tahoe sucker (1%). The total isotopic niche area (TA) of crayfish decreased between 1998 (6.02) and 2008 (3.01). The total isotopic niche area of Tahoe suckers decreased between years as well (9.75 and 4.65 respectively), while Tui chub isotopic niche area remained similar (4.27 and 4.38, respectively).

Crayfish at Lake Tahoe had a total niche area of 3.01. Marlette Lake crayfish had a total niche area of 1.98, the lowest measured, while Emerald Bay and Fallen Leaf Lake had the largest crayfish niche between the four lakes (7.05 and 7.21 respectively; Figure 3-13). Crayfish total niche area overlapped with Tahoe sucker in Lake Tahoe, Fallen Leaf Lake, and Donner Lake. Crayfish also overlapped with Tui chub in Lake Tahoe and Donner Lake. There was no overlap in Marlette Lake and Emerald Bay between crayfish and nongame fish. Crayfish isotopic total niche area was higher in lakes with lower crayfish numbers ($y=-0.11x+9.74$, $R^2 = 0.58$), while Tahoe sucker total niche area increased with higher crayfish numbers ($y=0.12x+1.76$, $R^2 = 0.23$; Figure 3-13). Tahoe suckers in Lake Tahoe between years only increased slightly in total niche area although Lake Tahoe has the highest number of crayfish.

Discussion

Seasonal variation and density

Collections made from Sunnyside at depths comparable to historical data indicate that crayfish densities are highly variable across years. By depth, crayfish density increased later in the summer, congruent with previous research on crayfish populations in the oligotrophic Lake Tahoe, where crayfish populations increased during the warmer summer months and then decreased in the fall as lake temperature began to drop (Abrahamsson and Goldman 1970, Flint and Goldman 1975). Higher crayfish densities we observed later in the summer may have resulted from an increase in food availability in the nearshore, which supports high biodiversity (Strayer and Findlay 2010). Alternatively, increased metabolic activity, driven by higher temperatures in the littoral zone in late summer may have resulted in crayfish moving to areas with higher prey density.

Data collected by Abrahamson and Goldman (1970) and Flint and Goldman (1975) showed maximum densities of introduced crayfish in Lake Tahoe occurring around 10 to 20 meters; however, data collected between 2008 and 2015 shows a shift of maximum densities occurring around 20 to 30 meters during the summer, with migrations to deeper waters in the winter. Our data show similar results with crayfish numbers increasing in the nearshore in late summer. We have hypothesized, based in part on the findings of Flint and Goldman (1975), that this is driven by temperature and bioenergetic efficiency, though this has not been shown conclusively. Crayfish density in Lake Tahoe is greater in the nearshore and tends to spike at around 20 to 30 m, reinforcing the significance of this depth for ongoing monitoring. Previous research in the 1970s suggests that under low densities (0.16 adult/m^2) crayfish stimulate periphyton productivity by removing old senescent cells (Flint 1975). The shift of crayfish densities to multiple depths may have large consequences on periphyton and benthic invertebrate densities within Lake Tahoe, altering nutrient cycling, food resources, and result in a loss of biodiversity and homogenization of benthic invertebrates at these depths affecting the nearshore food web.

Habitat selection

Cobble and boulder can provide refuges from both fish predation, cannibalism, and ultraviolet damage, and the abundance of cobble in certain systems can set the upper limit of crayfish abundance (Nystrom et al. 2006, Capelli and Mannuson 1983, Lodge and Hill 1994, Guan and Wiles 1996, Kirjavainen and Westman 1999). Cobble, gravel and boulder substrate was the preferred habitat preference of crayfish in Lake Tahoe. Similarly, crayfish in another ultra-oligotrophic lake, Crater Lake, preferred cobble and boulder habitat. Crayfish in Lake Tahoe were found in habitats beyond cobble and boulder, suggesting that maximum carrying capacity may have been reached in the cobble and boulder areas of Lake Tahoe forcing crayfish into less suitable habitats.

Lake attributes and crayfish density

Temperature regulates activity levels and reproduction stages in crayfish (Capelli and Magnuson 1976, Berrill and Aresnault 1982, Bubb et al. 2002, Gherardi et al. 2002) and, similar to other studies in lentic ecosystems, appeared to be a major factor influencing timing and movement of crayfish during the summer months in Lake Tahoe (Flint and Goldman 1975, Lozan 2000, Barbaresi and Gherardi 2001, Bubb et al. 2002, Bubb et al. 2004). Crayfish CPUE and temperature in Lake Tahoe show a significant relationship similar to other studies (Flint and Goldman 1975, Lozan 2000, Barbaresi and Gherardi 2001, Bubb et al. 2002, Bubb et al. 2004). Bubb et al. (2002) found that crayfish stopped making long distance movements when water temperature dropped to an average of 4.2°C, close to the mean temperature of Tahoe. In Tahoe crayfish moved from lower temperatures around 4°C to warmer water the nearshore in the spring. Average water temperature below 20 meters is less than 4.0°C, a temperature which greatly limits crayfish movements (Bubb et al. 2004). Crayfish density increased with surface temperature in Lake Tahoe. Recent observations of elevated lake water temperature (Coat et al. 2006) may encourage longer periods of activity in the nearshore by these non-native species, resulting in potential declines of benthic invertebrates, native fish density and disruption of their spawning habitats (Kamerath et al. 2007, Thiede 1997).

Lozan (2000) found that crayfish activity levels in Lake Tahoe were about 4 times higher at 20°C than 4°C (Lozan 2000). Likewise, Bubb et al. (2004) showed an almost logarithmic relationship between temperature and movement in radio-tagged signal crayfish, with very little movement at 4°C, and slightly higher at about 7°C, but progressively increased movement at temperatures between 12°C and 16°C. Crayfish activity in Lake Tahoe increased around 5 to 7 °C. Rutledge and Pritchard (1981) showed that the activity of signal crayfish was maximized at 20 °C, which is near the upper surface temperatures of Lake Tahoe and surrounding mountain lakes in the summer. The activity of signal crayfish increases dramatically at water temperatures of between 8 and 15 °C. The peak density of crayfish in the nearshore was around 20°C in August at

Crystal Bay and July at Sand Harbor, while the lag time between the two locations could be due to differences in gradients and water currents between the two locations.

Similar to the regression analysis, cluster analysis indicated a strong relationship with Ward Creek discharge and snowpack water equivalency (SWE), which indicated that crayfish respond to local site-specific characteristics similar to findings in Larson and Olden (2011). Cluster analysis indicated that 4 of the 7 variables were correlated with one another. Increased discharge into Lake Tahoe could be bringing additional nutrients into the system allowing for less movement when foraging for resources and therefore less exposure to predators and more energy for reproduction.

Trophic interactions

Flint and Goldman (1975) observed large schools of Tahoe suckers and Tui Chub hiding under boulders in shallow waters, similar to crayfish preferred habitat. During our snorkeling surveys no Tui chub or Tahoe suckers were observed. Like crayfish, the Tahoe sucker and benthic Tui chub take shelter in crevices between stones, and feed mainly on benthic invertebrates. Any differences in the bottom substrate would similarly affect both the abundances of benthic fish and crayfish. Competition for food and space, which could lead to exposure and predation from other species and physical disturbances, are among the most important processes structuring biological communities (Underwood 1986, Brewer 1988). Crayfish may be competing with nongame fish for interstitial habitat and displacing individual fish, similar to the negative relationships between abundance of fish and crayfish populations in streams reported by Guan and Wiles (1996) and Peay et al. (2009). At Crystal Bay (North Stateline) and Sunnyside no fish were captured during the summer months in 2012. Between 1991 and 2012, there was a 94% decrease in total catch at Sugar Pine Point. Crayfish decrease fish survival by direct predation on eggs, larvae and juveniles (Dorn and Mittelbach 2004, Mueller et al. 2006, , Setzer et al. 2011) and earlier seasonal crayfish activity in the nearshore due to increasing lake temperatures may increase the likelihood of crayfish interacting with nongame fish during the spawning season and early larval and juvenile development in the nearshore.

No apparent niche overlap occurred between crayfish and nongame fish in Lake Tahoe in 1998. However, crayfish and Tahoe suckers had very similar $\delta^{13}C$ and $\delta^{15}N$ values in 2008, with total isotopic niche area decreasing for both species, suggesting isotopic niche area overlapping and therefore a more direct competition for resources. Such intraspecific competition between crayfish and Lake Trout could enhance the interspecific competitions within the nearshore and vary overtime as crayfish populations fluctuate between years. Similar food sources have been found between crayfish and benthic fish (Guan 1995, Olsson et al. 2008). However, historical research has suggested seasonal and spatial variation in the diet among nongame fish that could be a result of the density of crayfish during that time (Miller 1965, Baker 1967, Evan 1969, Tucker 1969). As crayfish densities increase nongame fish may have to forage on a broader range of food sources and over a larger geographical area. Fish also displaced from shelters by crayfish would also be more vulnerable to piscivore predators, such as lake trout found in Lake Tahoe and Fallen Leaf Lake. Crayfish may affect abundance of benthic nongame fish through shelter competition and predation as indicated by niche overlap, but most importantly by direct predation on benthic fish and fish eggs (Guan 1994, Guan and Wiles 1996). As crayfish continue to increase in density at different depths, nongame fish may continue to have reductions in their populations. This may not lead to ecological extinction (few left with negligible ecological function) or eventual local extinction, but certainly to very small and widespread populations within Lake Tahoe and other surrounding lakes.

Observed shifts to benthic energy sources are speculated to be an early indicator of impending changes to benthic invertebrate and fish community composition and biomass in lakes (Vander Zanden and Vadeboncoeur 2002, Vander Zanden et al. 2003). Data collected by Caries et al. (2013) of the benthos of Lake Tahoe shows that benthic invertebrate assemblages have been substantially altered and declined by nearly 50-80%, since the last comprehensive survey of Lake Tahoe zoobenthos in 1962-1963 (Frantz and Cordone 1996); suggesting one potential cause in the decline is crayfish. However, little is known about the impacts from invasive species on nongame benthic fish species in the western United States. Nearshore areas in lakes provide a majority of the native fishes spawning habitat and supports fish production. Even if predator fish populations are present, crayfish can maintain substantial populations (Abrahamsson and Goldman 1970, Momot et al. 1978, Lodge and Hill 1994, Nystrom et al. 2006).

Interactions between invasive species and contemporary food web structures are thought to favor invasive species and therefore alter biogeochemical cycling and biotic composition of the newly invaded areas (Lockwood et al. 2005). The predator-prey dynamics and changes in consumers within the food web may have profound effects on habitat complexity in lakes resulting in direct and indirect influences on a lakes benthic production (Lodge et al. 1994). Expansion of crayfish populations could reduce biodiversity and increase biotic homogenization in benthic invertebrates and nongame fish in a short period of time (Twardochleb et al. 2013). Depending on the extent of the control, policy makers should be able to develop mechanisms to control and manage this species and allow for invertebrate and nongame fish communities to recover. Considering the recent losses of benthic invertebrate abundance and decrease in nongame fish in the nearshore, there is a clear need to develop a strategy for the most efficient and effective management to control crayfish densities in Lake Tahoe.

Thus, the findings and application of this research provides an assessment and baseline of signal crayfish and distribution in the Central Eastern Sierra's for future studies. This data allows managers to determine potential strategies, costs and environmental externalities to the ecology of Lake Tahoe as a result of management and conservation efforts related to these invasive species. This work also expands on the geographical distribution of signal crayfish on a landscape level and factors influencing crayfish density. Future research should focus on understanding the life-history and mechanisms controlling this species if they are to be controlled in Lake Tahoe or Crater Lake.

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Table 3-1. Basis morphological characteristics of the Truckee River region study lakes.

Lake	Max Depth (m)	Surface Area (ha)	Shoreline (km)
Donner	70.0	390.0	12.07
Emerald Bay	68	--	--
Fallen Leaf Lake	126	520	12.6
Lake Tahoe	501	49452.6	120.86
Marlette Lake	11.0	55	NA

Table 3-2. Results of model comparison for crayfish CPUE versus lake factors. AIC was used to compare contrasting models, lower AIC indicate a better model as evidenced by a difference of at least 2.0 of the next best model. All models were on untransformed data. *P*-values refer to the significance of the model against a null model of no relationship.

Model	F	*P*	R^2	ΔAIC
M_3:Discharge	5.88	0.04	0.4	Δ23.93
M_4: Discharge+ Secchi	2.63	0.13	0.4	Δ25.91
M_5: Discharge+ Snow pack	2.61	0.13	0.4	Δ25.93
M_1:Snow pack+ Discharge + Diatoms +Secchi+Surface	0.63	0.69	0.44	Δ28.26
M_2: Snow pack+ Discharge + Diatoms +Secchi+Surface+Stability	0.44	0.82	0.47	29.76

Table 3-3. Mean (±SD) stable isotope values of carbon and nitrogen ($\delta^{13}C$ and $\delta^{15}N$) for various taxa collected from the Tahoe Basin Watershed.

Location	Year	Species	N	$\delta^{15}N$	$\delta^{13}C$
Donner Lake	2003	Tahoe Sucker	11	6.93±0.31	-22.75±1.02
	2003	Redside Shinner	9	7.57±0.24	-24.34±0.33
	2011	Crayfish	9	6.59±0.35	-23.12±0.52
Emerald Bay	2005	Crayfish	11	4.21±0.72	-20.48±0.2
	2005	Speckled Dace	6	4.28±0.09	-18.9±0.6
	2005	Tahoe Sucker	13	1.91±0.07	-25.53±0.56
Fallen Leaf Lake	2005	Crayfish	5	6.51±0.45	-23.06±0.54
	2005	Tahoe Sucker	4	6.3±0.03	-25.53±0.16
	2005	Tui Chub	11	6.75±0.03	-20.88±0.3
Lake Tahoe	2008	Tahoe Sucker	9	4.33±0.15	-14.8±0.58
	2008	Tui Chub	16	5.13±0.1	-18.1±0.41
	1998	Crayfish	20	4.23±0.13	-15.67±0.49
Marlette Lake	2010	Crayfish	10	10.69±0.1	-21.79±0.39
	2010	Tahoe Sucker	31	11.7±0.1	-27.06±0.22
	2010	Tui Chub	10	13.13±0.12	-27.21±0.12

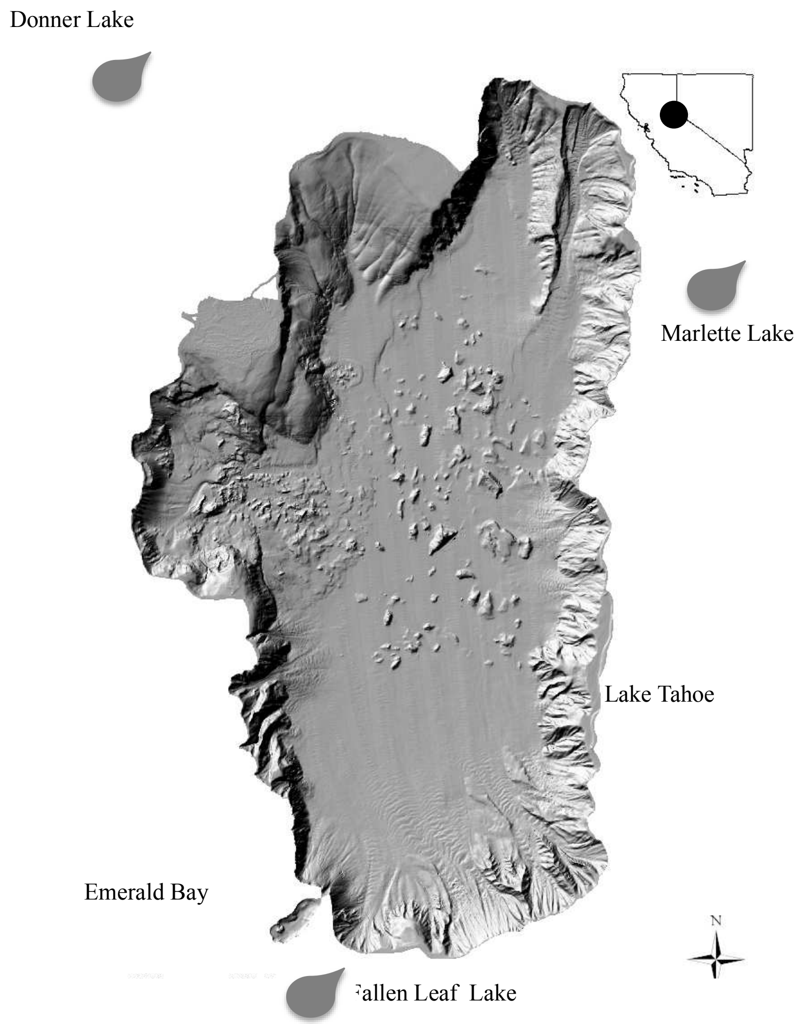


Figure 3-1a. Map of the Central Eastern Nevada region. Red dots indicate lakes sampled for crayfish and nongame fish.

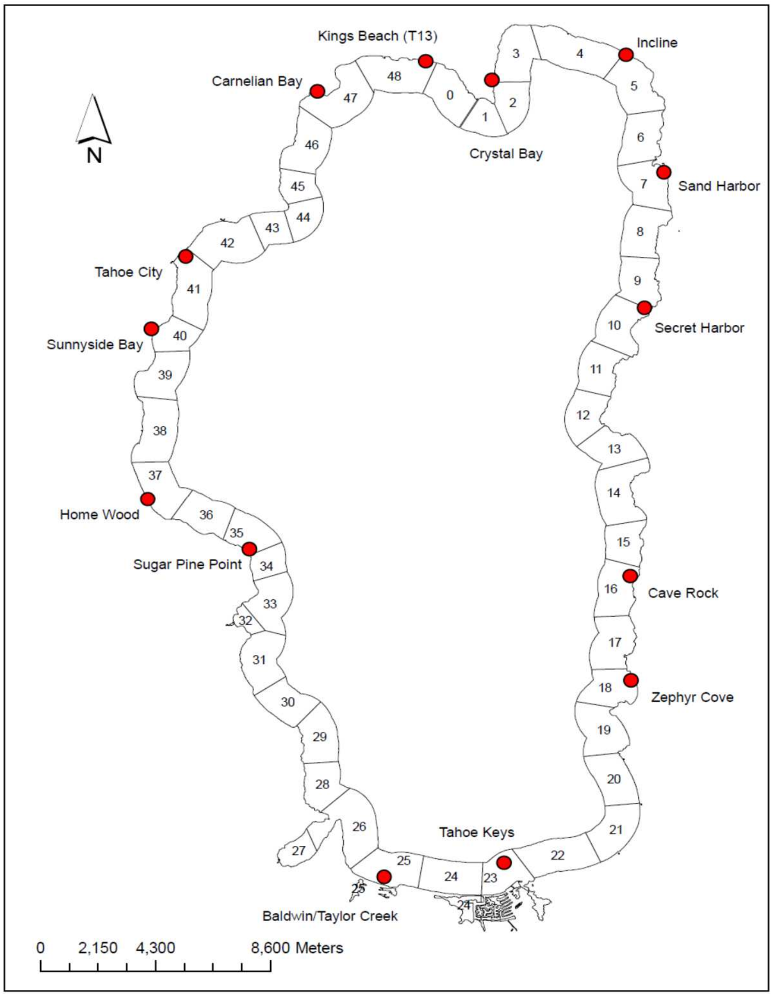


Figure 3-1b. Map of Lake Tahoe and crayfish and nongame fish sample locations. Snorkel locations are denoted by numbered polygons along the nearshore, while red dots denote location of long-line crayfish sampling transect locations around Lake Tahoe.

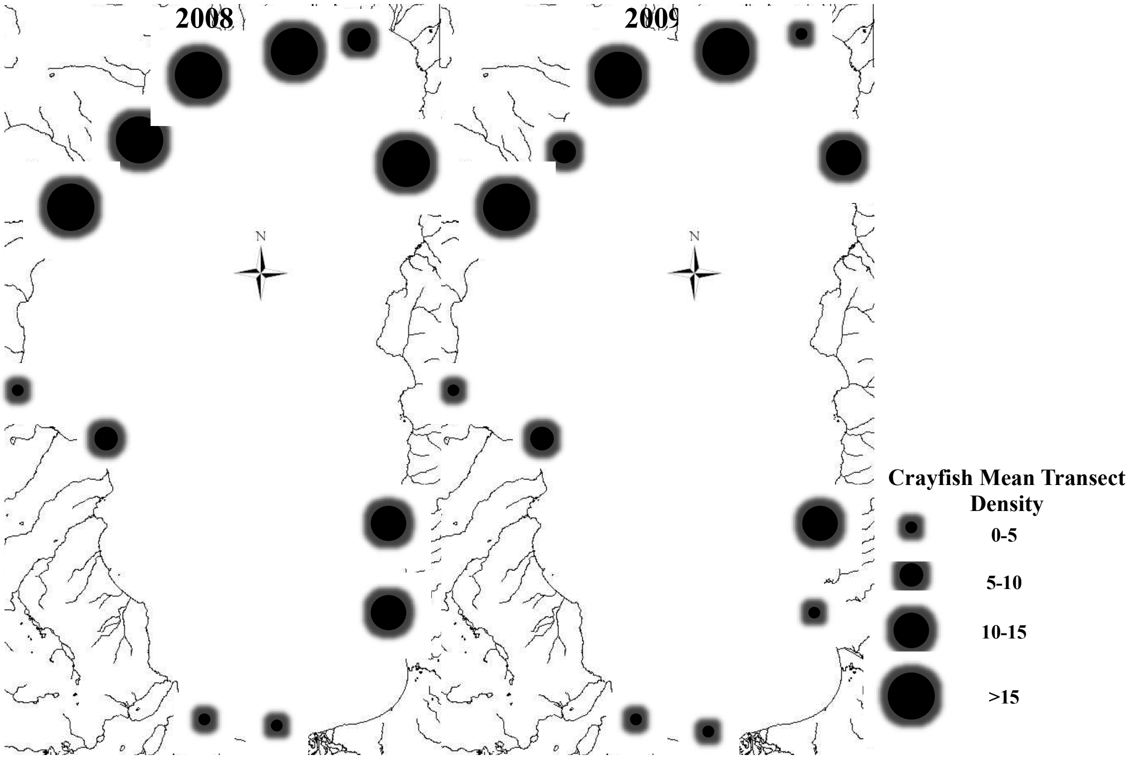


Figure 3-2. Crayfish mean transect densities in summer 2008 and 2009 at 14 locations around Lake Tahoe to determine densities in the nearshore.

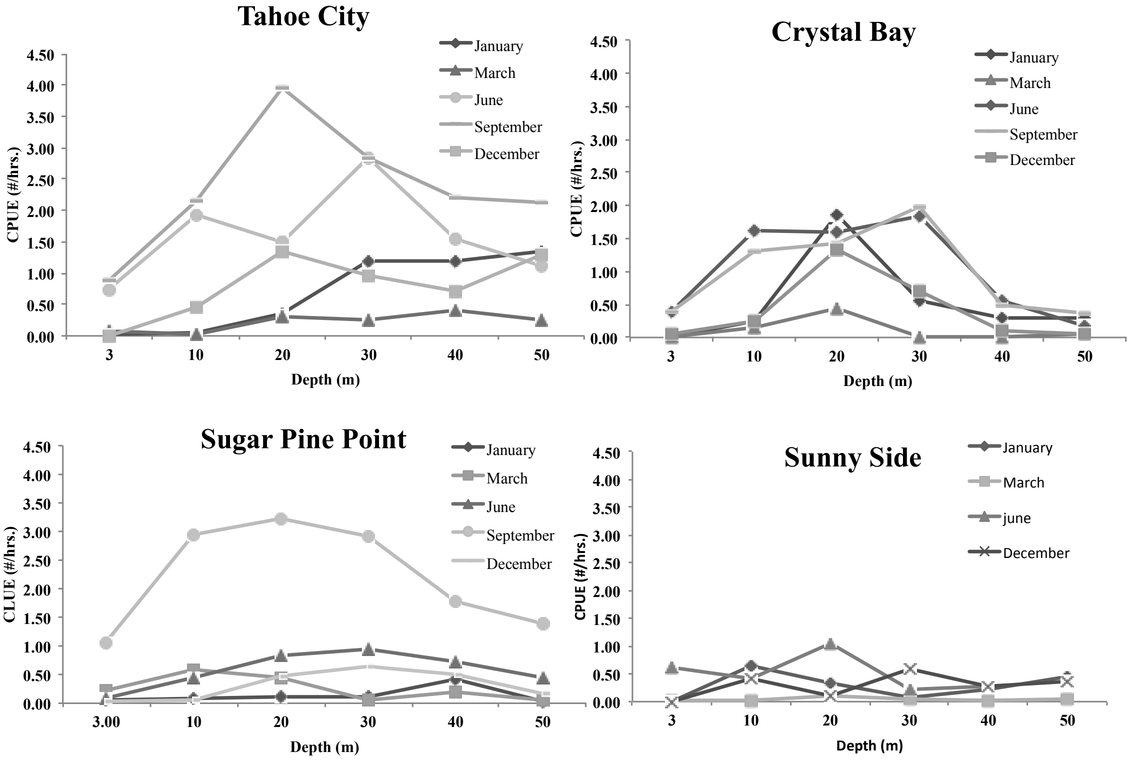


Figure 3-3. Crayfish CPUE by depth in Lake Tahoe from January to December 2012.

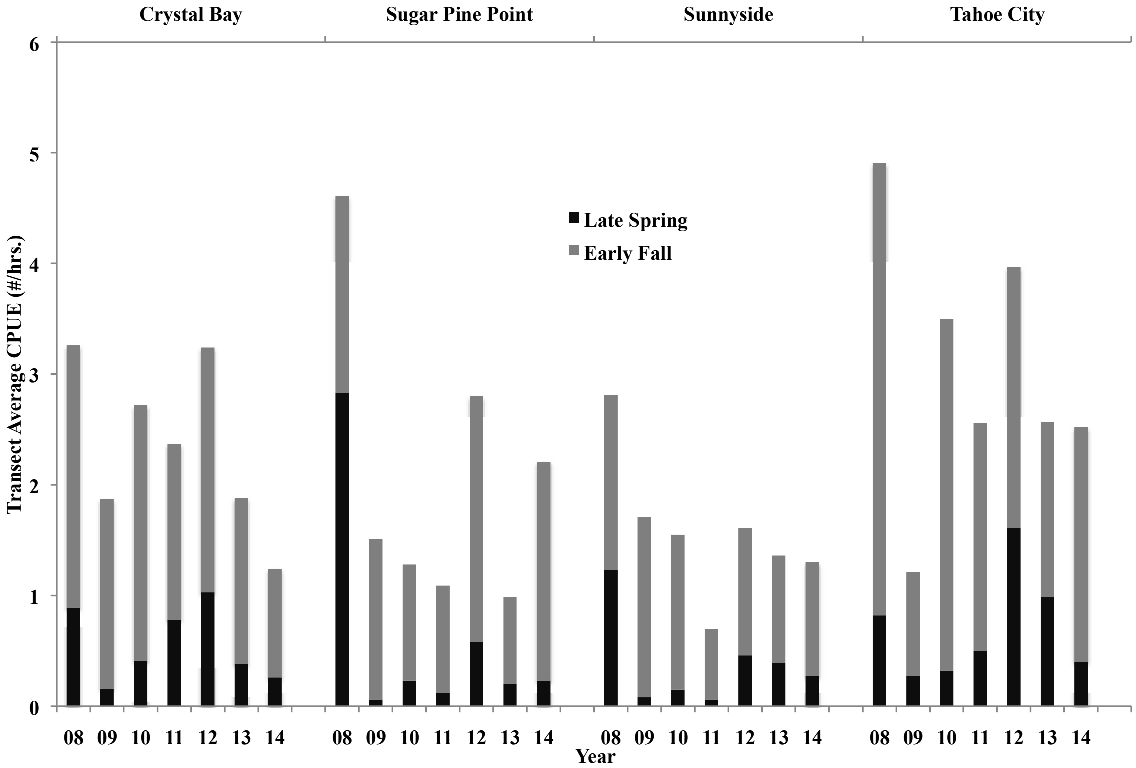


Figure 3-4. CPUE average per transect between 2008 and 2014 for 4 transects at the highest crayfish densities in Lake Tahoe. Transects were set in late spring (May/June) and early fall (August/September).

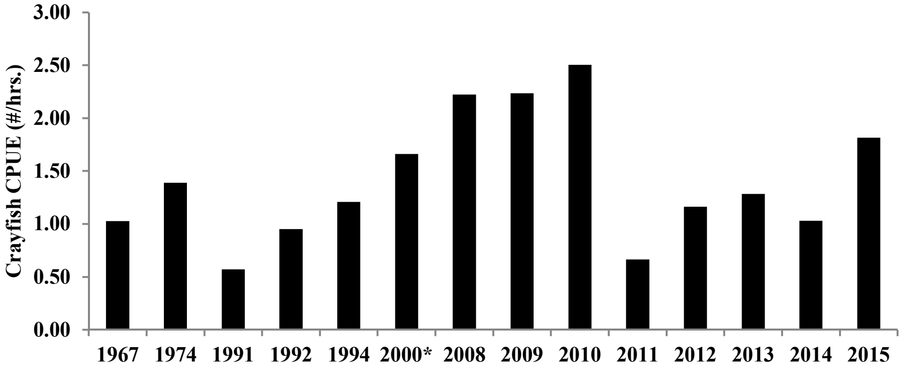


Figure 3-5. Average crayfish densities between 1967-2014 for 6 deeps (3, 10, 20, 30, 40, and 50 meters) at the Sunnyside transect location. The transect location is on the north end of Lake Tahoe at the Sunnyside location near the mouth of Ward. Data presented from Abrahamsson and Goldman 1968, Flint 1974, Chandra et al. 1991-2000. *Denotes a missing depth in the transect.

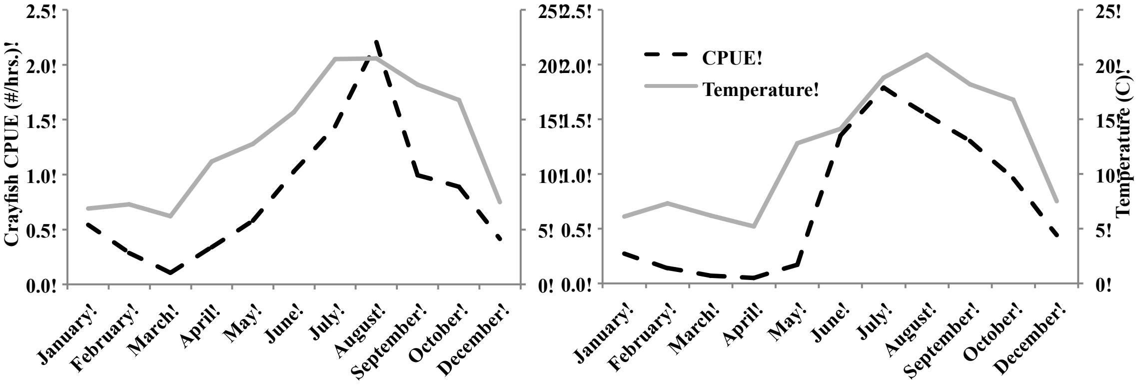


Figure 3-6. Average crayfish CPUE in 2012 at Crystal Bay and Sand Harbor, two locations with differing gradients, versus temperature in Lake Tahoe's nearshore.

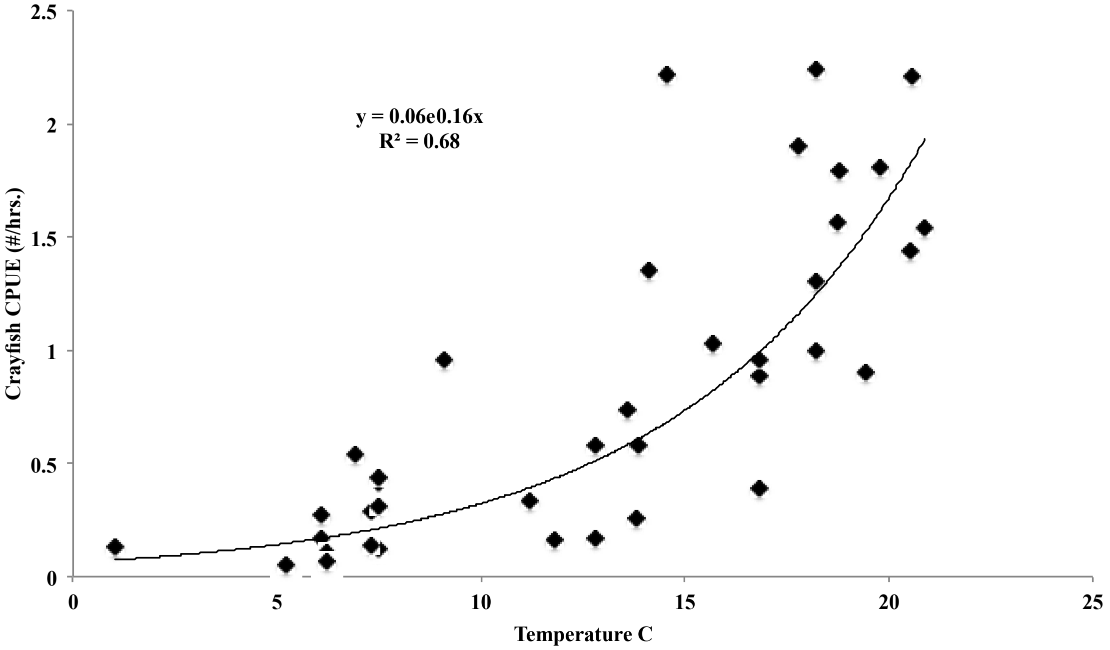


Figure 3-7. Overall crayfish CPUE in 2012 in Lake Tahoe from four locations with the highest crayfish densities in the nearshore versus temperature. The solid lines denote the best-fit exponential model. (Temperature = $-0.0623e^{0.1644x}$, $R^2 = 0.68$).

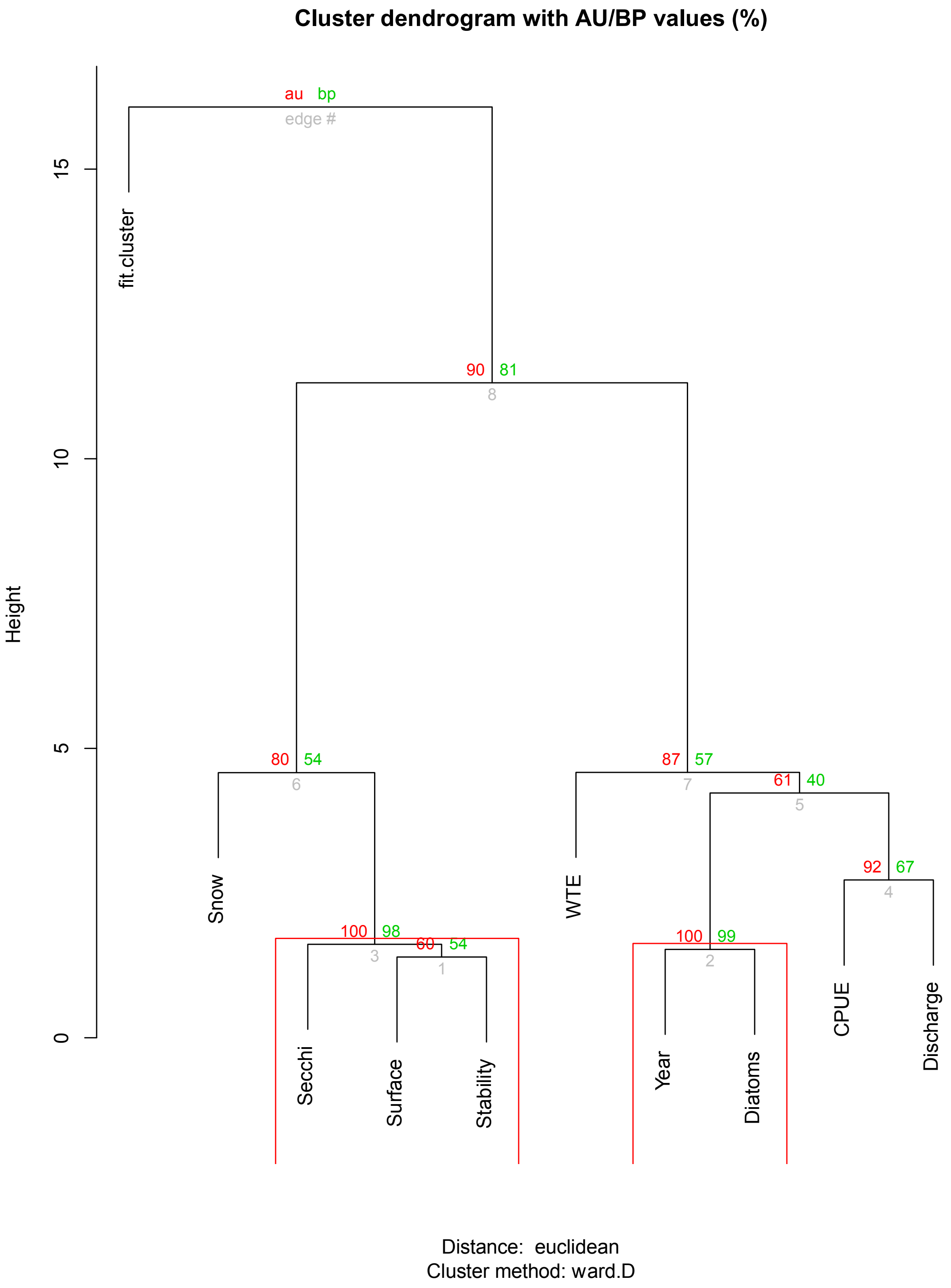


Figure 3-8. Cluster analysis of lake characteristics influencing crayfish CPUE. Red lines denote clustered characteristics.

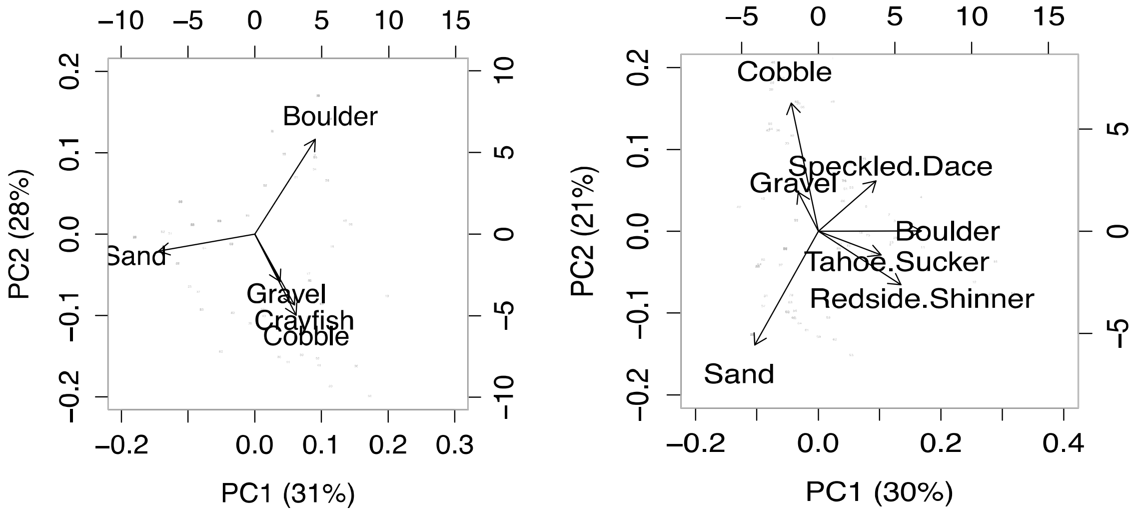


Figure 9. Principal components analysis with variation explained on axes to determine the habitat selection of crayfish (left panel) and nongame fish (right panel) at 1 and 3 m.

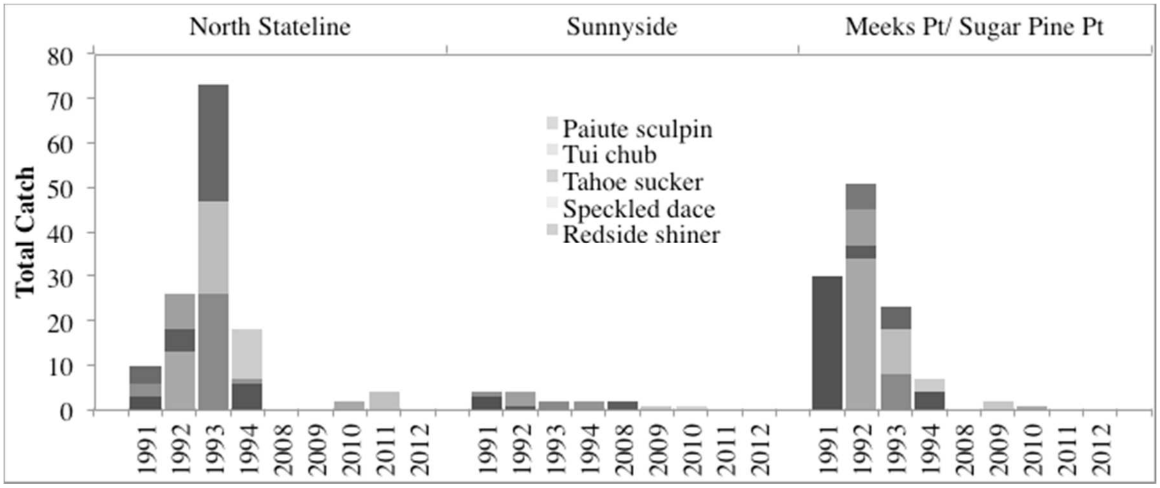


Figure 3-10. Total catch of nongame fish in Lake Tahoe at North State Line (Crystal Bay), Sunnyside, and Sugar Pine point between 1991 to 1994 and 2008 to 2012.

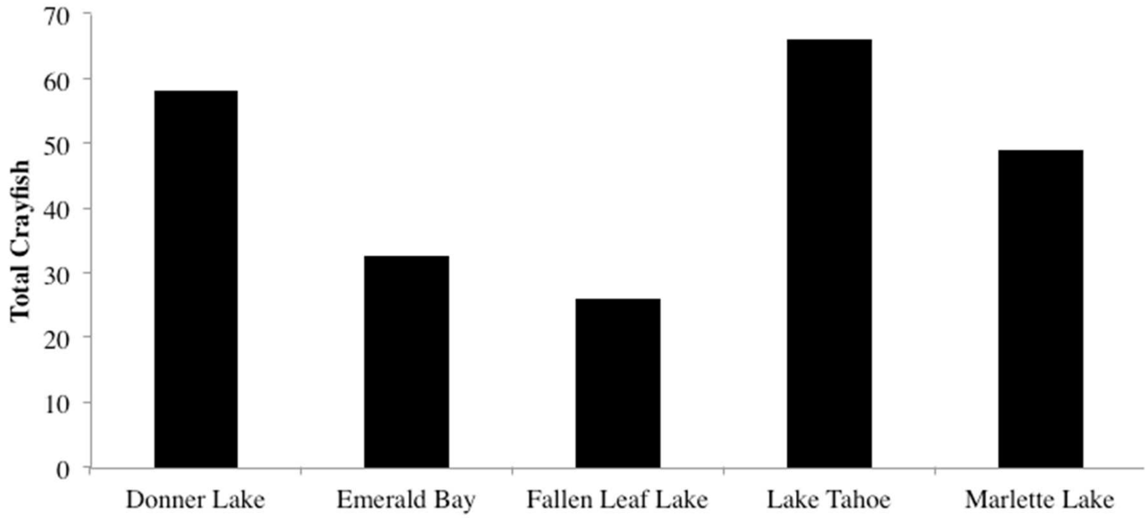


Figure 3-11. Total crayfish numbers at different lakes within the Tahoe region.

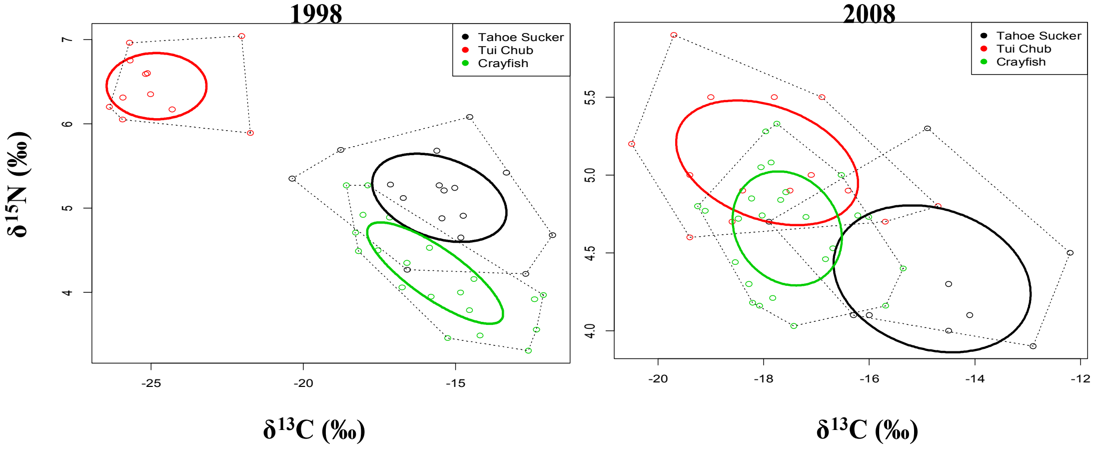


Figure 3-12. Population-level trophic niche widths in δ^{15}N and δ^{13}C for Lake Tahoe in a) 1998 and b) 2008. Please note differences in y-axis.

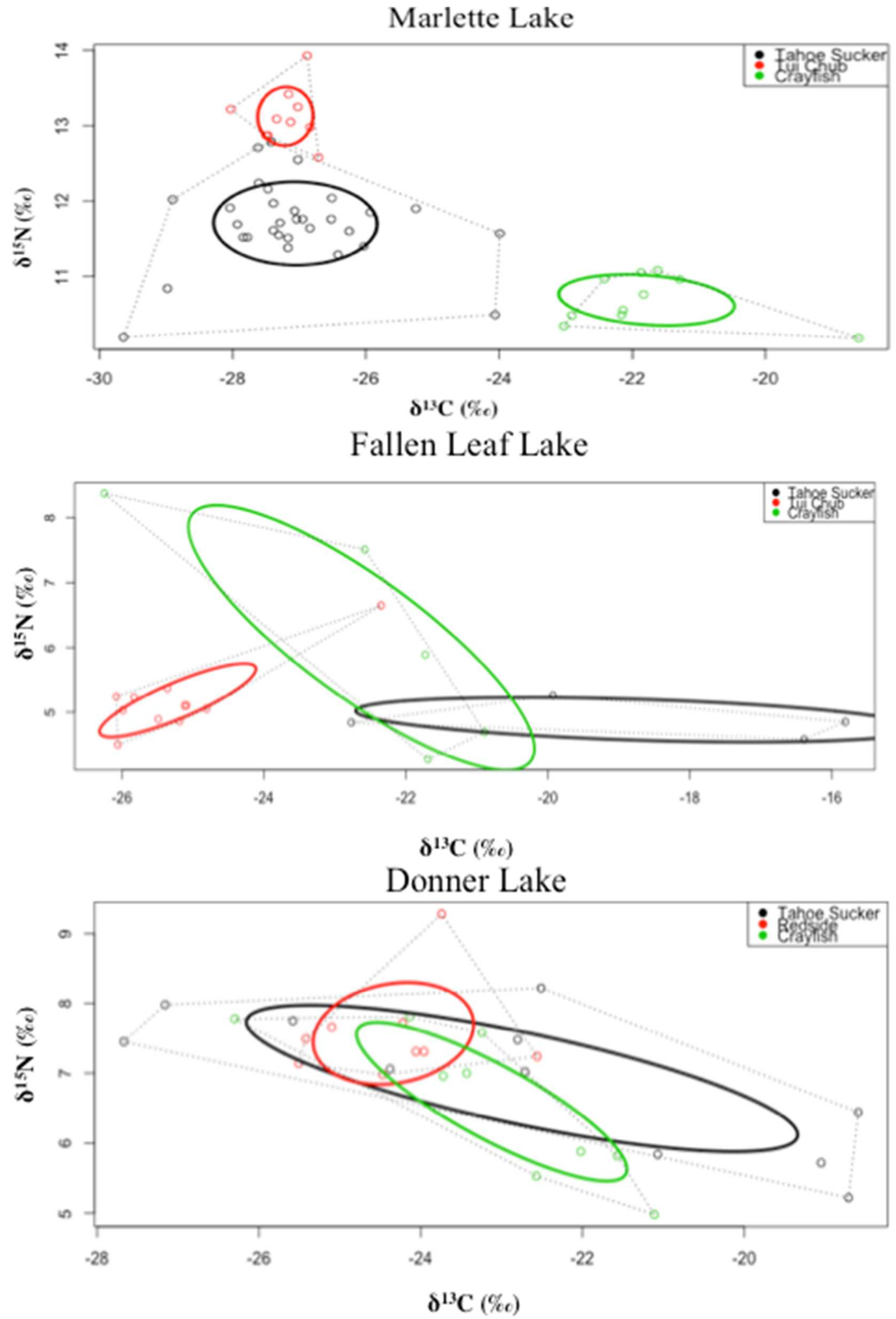


Figure 3-13. Population-level trophic niche widths in δ^{15}N and δ^{13}C for lakes in the Tahoe Basin. A) Marlette Lake, B) Fallen Leaf Lake, and C) Donner Lake. Please note differences in y-axis.

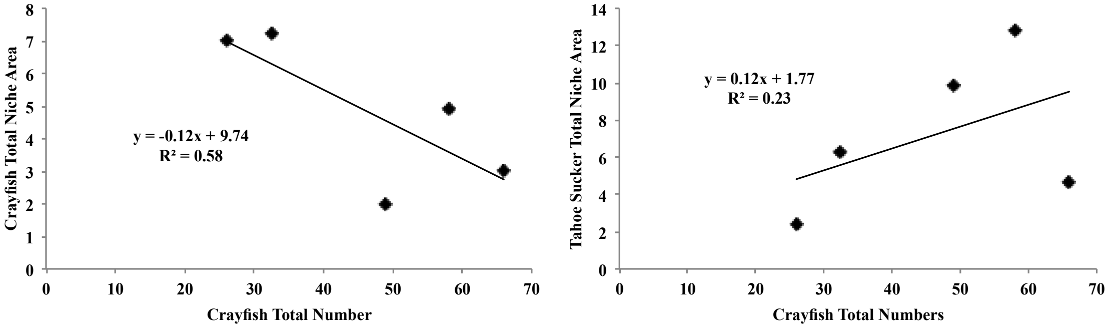


Figure 3-14. Regression analysis between a) crayfish total numbers and the Total trophic niche Area (TA) and Tahoe sucker total trophic niche area and b) crayfish total numbers and trophic niche Total Area (TA) in the nearshore.

Supplemental Tables

Supplemental Table 1-1S. Mean Maximum Likelihood estimates (and standard Errors) for data clones derived from SAIR Bayesian Stable Isotope model runs.

Data Clones	Chironomidae	Gastropoda	Trichoptera
k1	0.16 ± 0.11	0.67 ± 0.07	0.03 ± 0.45
k3	0.17 ± 0.69	0.68 ± 0.04	0.02 ± 0.02
k5	0.17 ± 0.05	0.69 ± 0.03	0.01 ± 0.01
k8	0.17 ± 0.04	0.69 ± 0.02	0.01 ± 0.01
k10	0.17 ± 0.03	0.69 ± 0.02	0.01 ± 0.08
k13	0.17 ± 0.03	0.69 ± 0.02	0.01 ± 0.01
k15	0.17 ± 0.03	0.69 ± 0.02	0.01 ± 0.01

Supplemental Table 1-2S. Descriptive statistics for length and weight of all crayfish caught in Lake Tahoe in 2008. Total number of crayfish measured was 1352 and 685 were female and 667 were males. Mean lengths and weights were not significantly different ($P > 0.5$).

Lake Tahoe Crayfish	Length (mm)	Weight (g)
Minimum	24.7	3.2
Median	39.8	13.9
Mean	40.0	14.9
SD	5.2	6.2
Maximum	57.3	47.6

Supplemental Table 1-3S. Results of regression models for crayfish CPUE versus temperature. All models were performed on untransformed data. *P*-values refer to the significance of the model against a null model of no relationship.

Model	Constant and Variance	K	F	*P*	R^2
M_1: C + B_1(Temperature)	7.516 + 6.34x	2	59.5	$3.24x^{10-9}$	0.62
M_2: C + B_1(Temperature) + B_2(Temperature$_2$)	$4.985 + 15.446x – 4.315x^2$	2	45.22	$1.15x^{10-10}$	0.715
M_3: C + B_1(Temperature) + B_2(Temperature$_2$) + B_3(Temperature$_3$)	5.316 + 13.332x - 1.829x2 - 0.744x3	2	29.44	$1.103x^{10-9}$	0.716
M_4: C + B_1(Temperature) + B_2 (Temperature$_2$) + B_3(Temperature$_3$) + B_4(Temperature$_4$)	4.983 + 16.447x - 8.354x2 + 3.864x3 - 1.027x4	2	21.51	$6.418x^{10-9}$	0.717

Supplemental Table 1-4S. Fish species composition by lake in the Tahoe Watershed Basin.

Species	**Latin Name**	**Donner Lake**	**Emerald Bay**	**Fallen Leaf Lake**	**Lake Tahoe**	**Marlette Lake**
Crayfish	*Pacifasticus lenisuclus*	X	X	X	X	X
Lake Trout	*Salvelinus namaychus*		X		X	
Lahontan Redside Shinner	*Richardsonius egregius*	X	X		X	
Lahontan Speckled Dace	*Rhinichthys osculus robustus*	X	X		X	
Tahoe Sucker	*Catostomus tahoensis*	X	X	X	X	X
Tui Chub	*Gila bicolor (obesa)*		X	X	X	X
Kokanee salmon	*Oncorhynchus nerka*	X	X		X	

Supplemental Table 1-5S. Descriptive statistics for carapace lengths of all male and female crayfish caught in nearshore and by longline during summer (June, July, August and September 2008, and June and September 2009) in Crater Lake. Descriptive statistics for overall crayfish weight of all males and females caught in the nearshore and by longline during the summer (June, July, August, and September 2008 and June and September 2009) in Crater Lake. Mean carapace length, weight, and standard deviation of all crayfish caught in Crater Lake in summer (June, July, August, September 2008, and June and September 2009; n=2137) was 39.0 ± 5.4 mm and 18.0 ± 7.5 g. Females were significantly larger (t-test for independent means, $p<0.0001$) than males (39.7 ± 5.6 mm versus 38.4 ± 5.2 mm, respectively; Table 3a; Figure 2). Females also weighted more than males (18.4 ± 7.5 g versus 17.8 ± 7.6 g, respectively; Table 3b; Figure 3). However, there was no significant difference between weights ($p=0.75$).

		Carapace length (mm)	
	Females	Males	All crayfish
Mean	*39.7	*38.4	39.0
Standard deviation	5.6	5.2	5.4
Median	39.5	38.1	38.7
n	961	1176	2137

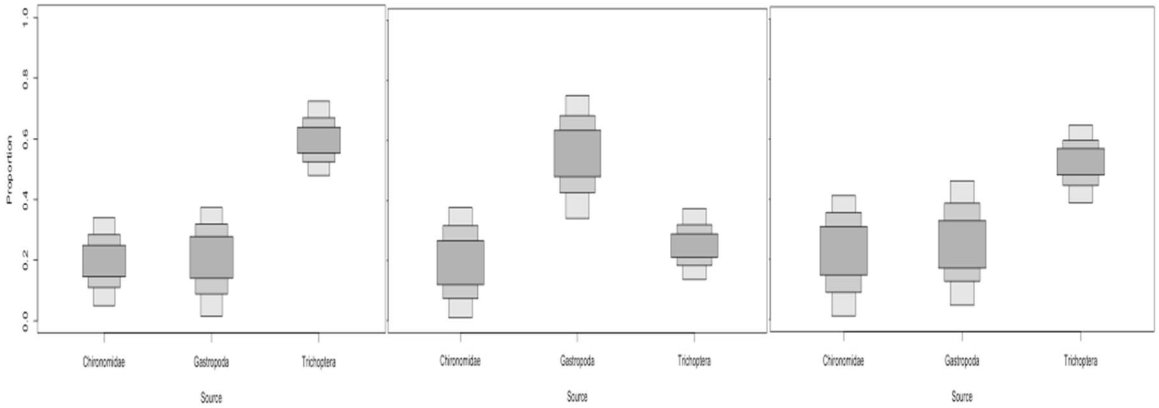
		Crayfish weight (g)	
	Females	Males	All crayfish
Mean	18.4	17.8	18.0
Standard deviation	7.5	7.6	7.5
Median	17.2	16.5	16.8
n	876	1050	1926

* significantly different (P=0.00002)

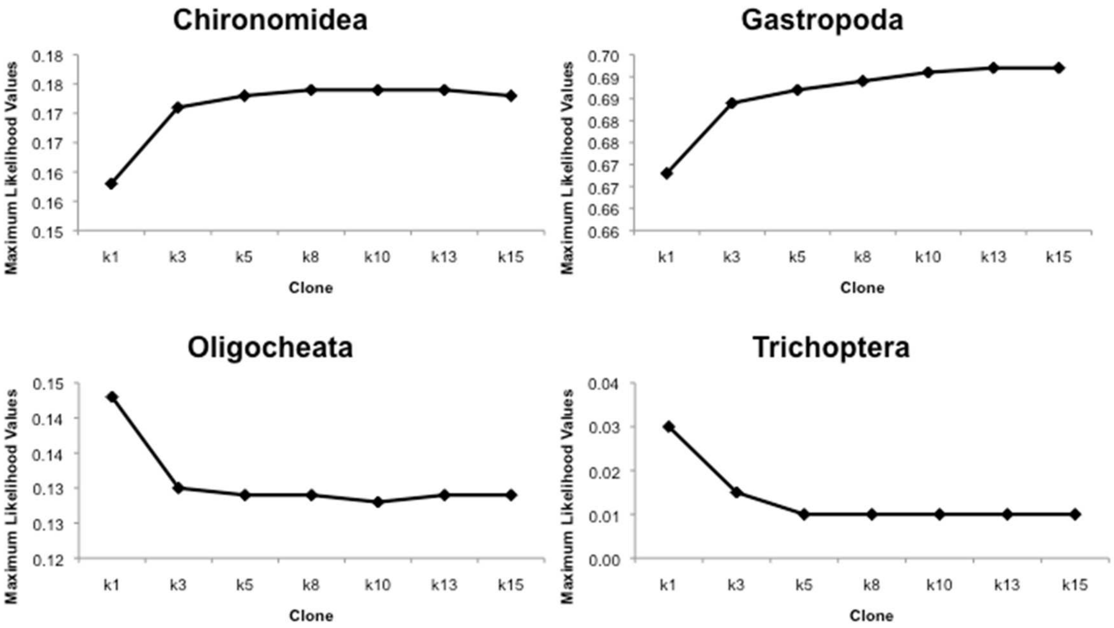
Supplemental Table 1-6S. Descriptive statistics for length and weight of all crayfish caught in Crater Lake and a subsample of crayfish caught in Lake Tahoe in 2008. Mean lengths and weights were not significantly different (P>0.5).

	Crater Lake (n=1467) female:625, male:842		**Lake Tahoe (n=1352)** female: 685, male:667	
	Length (mm)	**Weight (g)**	**Length (mm)**	**Weight (g)**
Minimum	18.5	1.6	24.7	3.2
Median	38.5	16.5	39.8	13.9
Mean	38.8	17.9	40.0	14.9
SD	5.5	7.8	5.2	6.2
Maximum	59.0	61.6	57.3	47.6

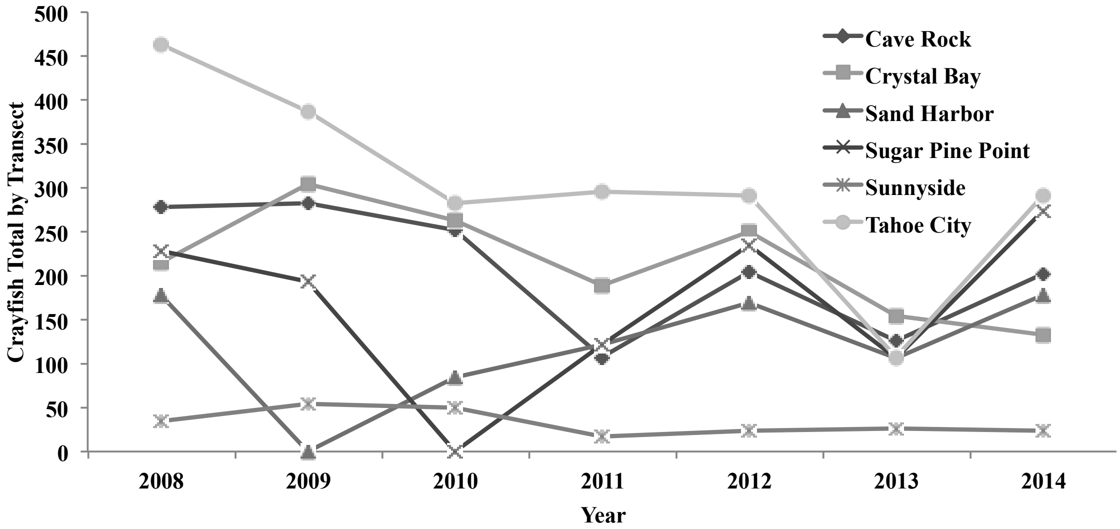
Supplemental Figures



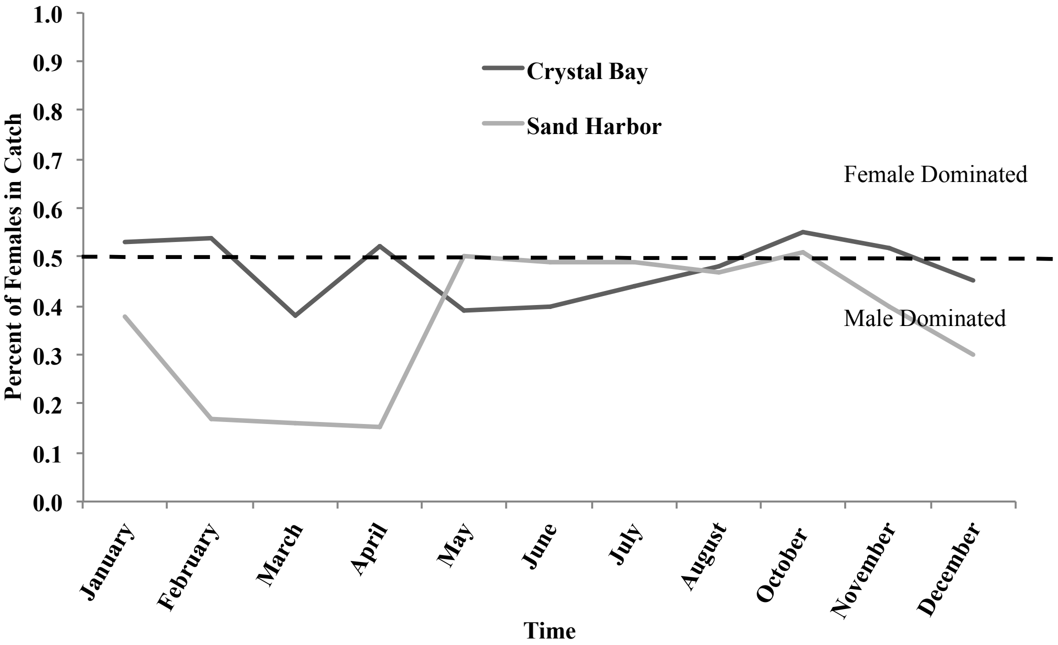
Supplemental Figure 1-1S. Dietary proportions for eulittoral food sources from a stable isotope Bayesian mixing model for crayfish at 3 locations: Cleetwood Cove, boundary of crayfish expansion, and Wizard Island. Boxes represent 50, 75, and 95% confidence intervals.



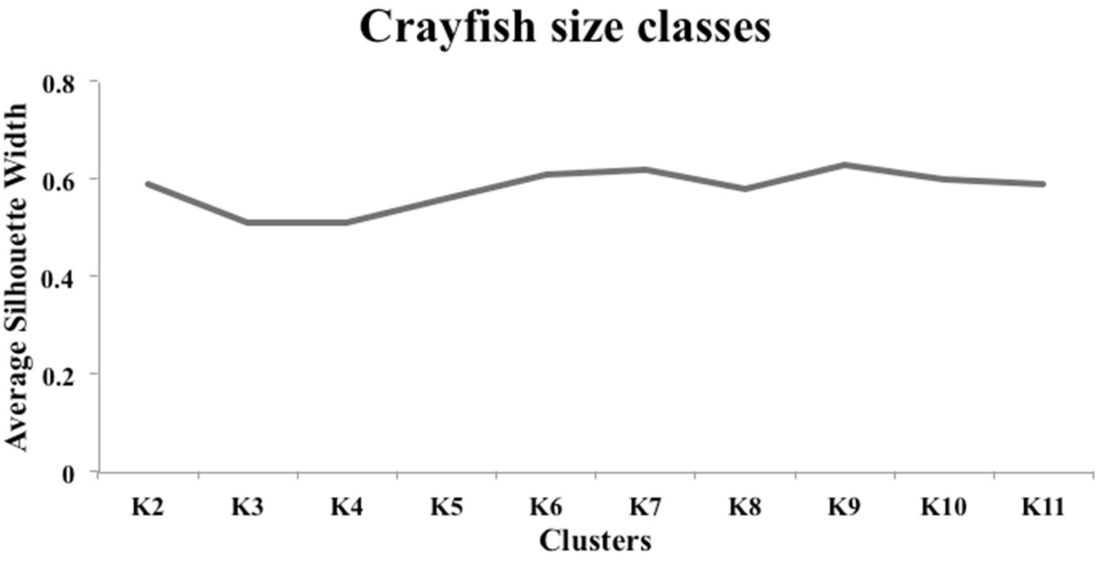
Supplemental Figure 1-2S. Mean Maximum Likelihood estimates for data clones derived from SAIR Bayesian Stable Isotope model runs.



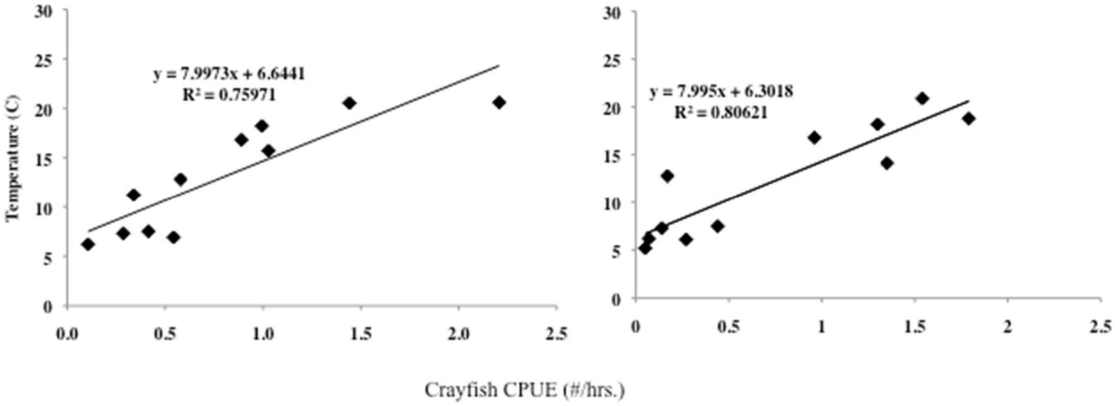
Supplemental Figure 1-3S. Total crayfish caught during August/September at 6 monitoring locations around Lake Tahoe between 2008 and 2014.



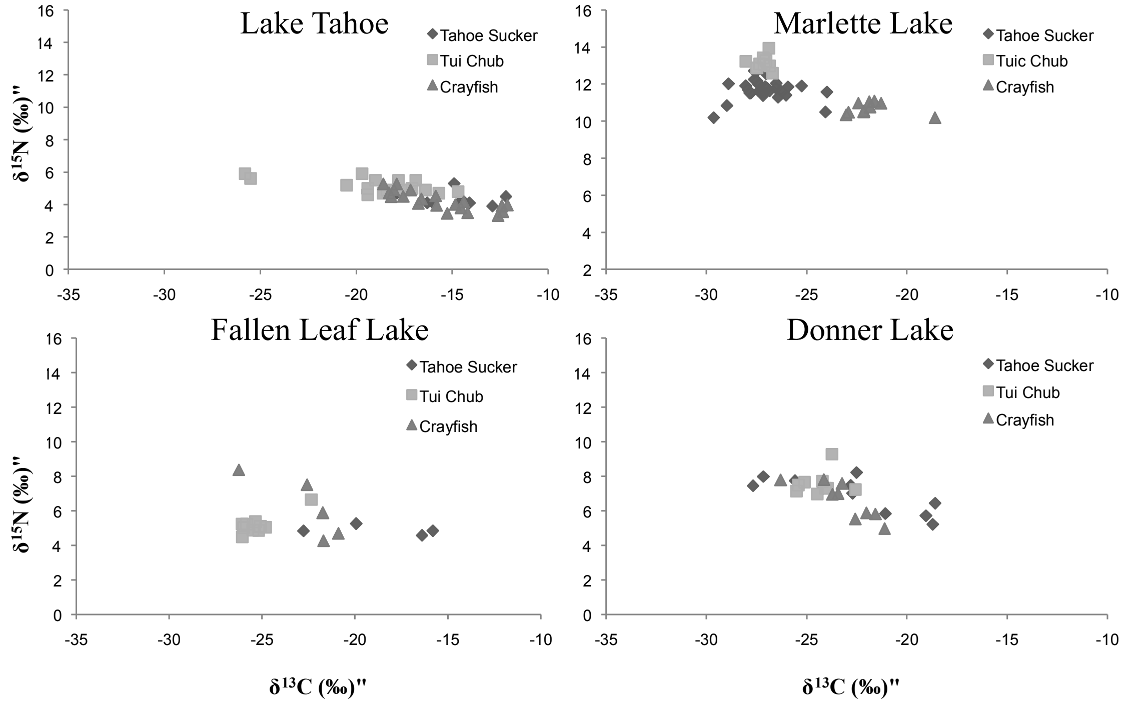
Supplemental Figure 1-4S. Seasonal changes in average transect trap catch dominance by gender at Crystal Bay and Sand Harbor in 2012.



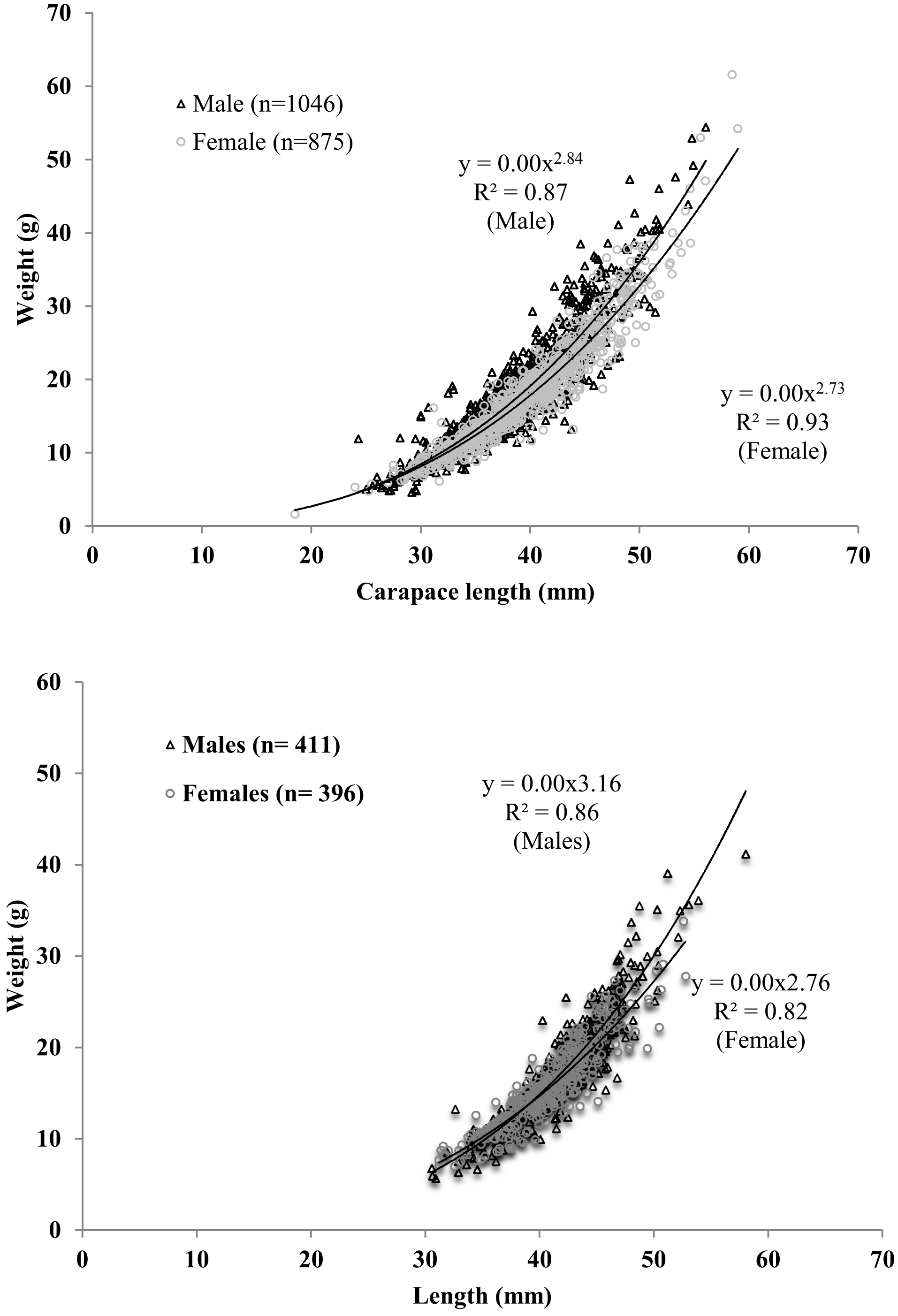
Supplemental Figure 1-5S. Average silhouette widths by the number of clusters. Crayfish size was determined by measuring the carapace length of crayfish taken from Sunnyside in 2008 and 2009. To account for large data sets and determine crayfish size classes we utilized cluster analysis using the “clara” function in Program R (Kaufman and Rousseeuw 1990). The mean of the dissimilarities of the observations of their closest medoid was used as a measure of the quality of the clustering. The average silhouette width was used to determine the best number of size classes.



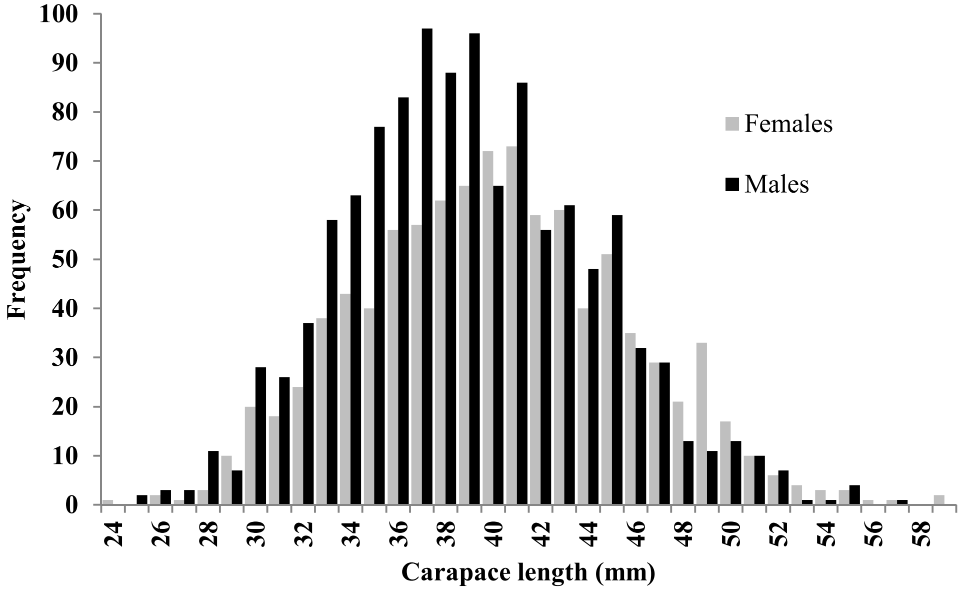
Supplemental Figure 1-6S. Regression analysis between crayfish CPUE and temperature at a) Crystal Bay and b) Sand Harbor in 2012.



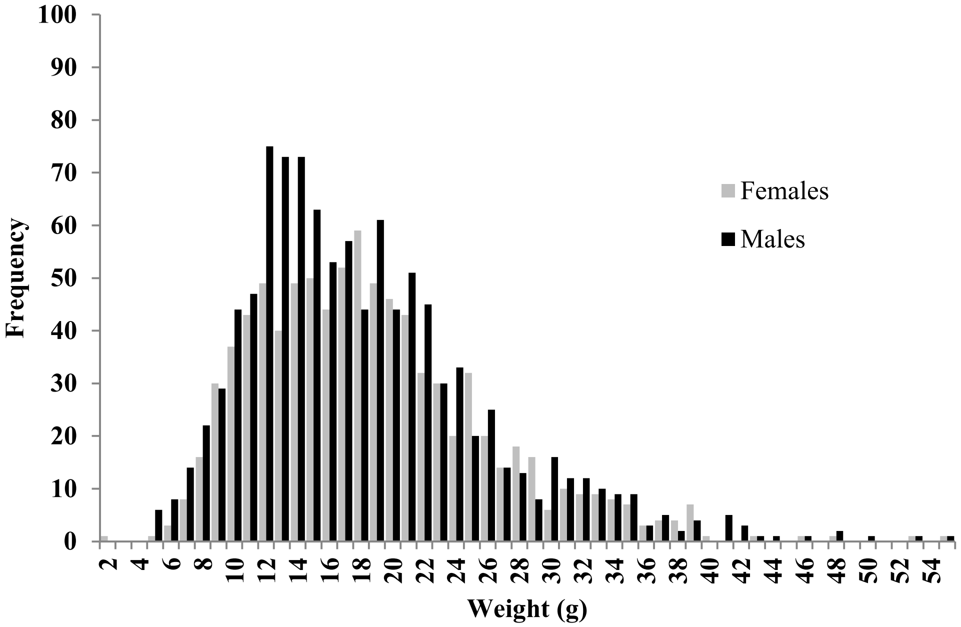
Supplemental Figure 1-7S. Food web in δ^{15}N and δ^{13}C for lakes in the Tahoe Basin. Data was collected in 1998 and 2008 on a range of taxa from Lake Tahoe and four surrounding lakes in the watershed with differing crayfish densities To understand the influence of crayfish on nongame fish consumers, we sampled multiple lakes with varying crayfish densities and nongame fish composition. Nongame fish and crayfish in each lake were collected using minnow traps deployed during the summer of 2010 and 2011 along 4 depths (1, 5, 8m) in the lakes. Fish catch was identified to species. Dorsal muscle tissue was collected from a subset of each species per collection and analyzed for natural abundance of stable isotope (carbon and nitrogen) to quantify trophic niche area.



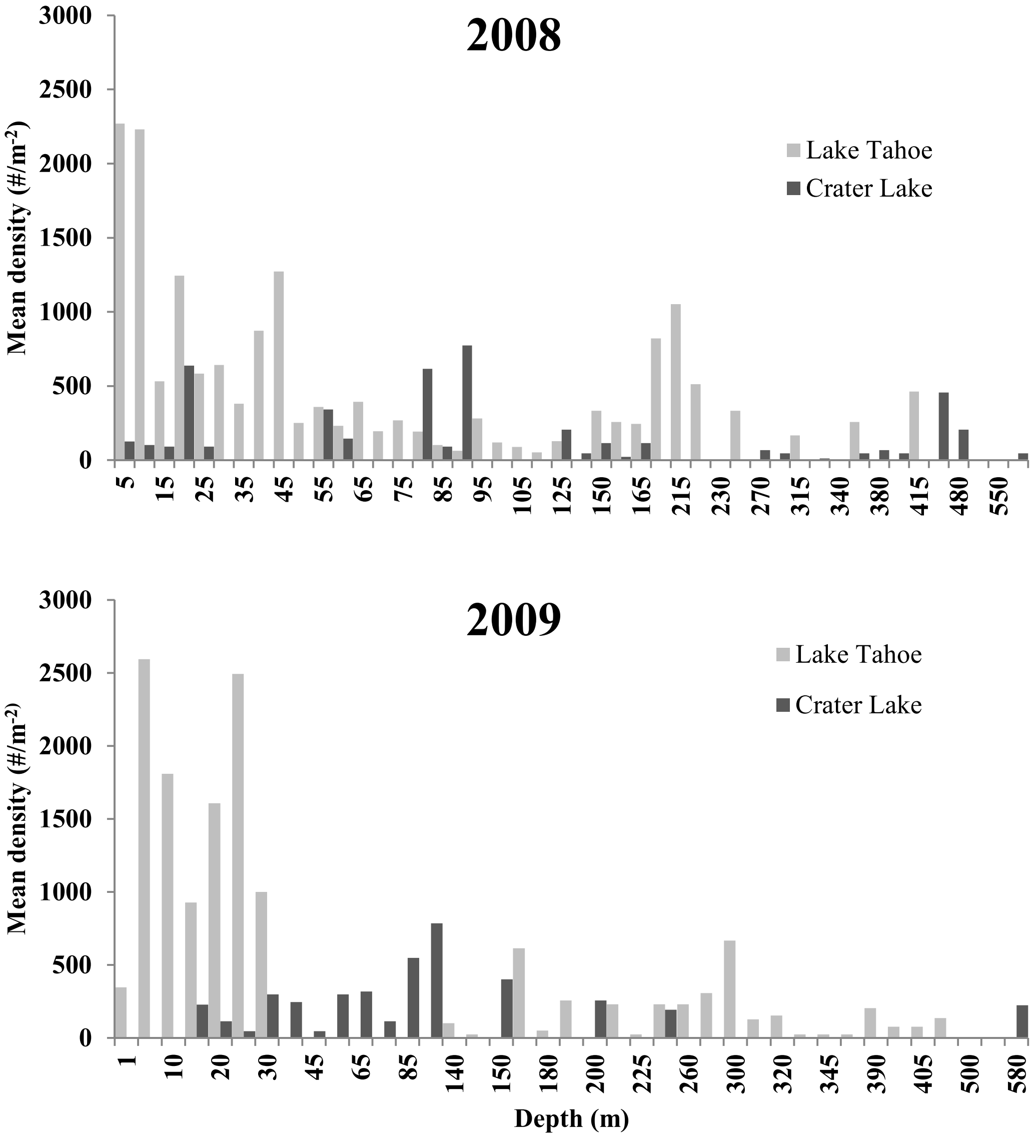
Supplemental Figure 1-8S. To facilitate comparison of crayfish dynamics in Crater Lake, with another large deep oligotrophic mountain lake, Lake Tahoe was sampled one week after each Crater Lake sampling period in 2008 and bi-monthly in 2009. To measure crayfish density and distribution along a depth gradient in Lake Tahoe, sampling was performed using paired minnow traps at 14 locations around the lake at depths of 3, 10, 20, 30, 40, and 50 meters. A total of 1352 crayfish (*Pacifasticus leniusculus*) were collected in 2008 from Lake Tahoe. Due to the large number of crayfish caught while sampling at Lake Tahoe only counts of crayfish per trap and gender was recorded during sampling in 2009. Length-weight relationship for male and female crayfish in Crater Lake. Crayfish from June, July, August and September of 2008, and June and September 2009 were combined because no significant difference was found among months; n=1921. Lines are length-weight models for males (top line and equation) and females (bottom line and equation) for Crater Lake. Length-weight curves were fit separately for males and for females for all but crayfish caught in June 2008, since weight was not recorded for these samples.



Supplemental Figure 1-9S. Size frequency distributions of the carapace length of all male (n=1176) and female (n=961) crayfish caught in summer (June, July, August, and September 2008; June and September 2009) in Crater Lake.



Supplemental Figure 1-10S. Size frequency distributions of the weight of all male (n=1050) and female (n=876) crayfish caught in summer (June, July, August, and September 2008; June and September 2009) in Crater Lake.



Supplemental Figure 1-11S. Comparisons in 2008 and 2009 of density, by depth, of benthic invertebrates (chironomids and oligochaetes combined) in Lake Tahoe and Crater Lake. Crater is represented in 2008 by transect from Wizard Island; Tahoe is represented by a transect from McKinney Bay. Crater Lake is represented in 2009 by a transect from Cleetwood Cove; Tahoe is represented by a transect from Camp Richardson. Benthic invertebrate densities were much higher in Lake Tahoe than in Crater Lake in 0-50 m in depths, but were only slightly higher at 50-500 m depths. Please note differences in depth on x-axis.

Supplemental Figure 1-12S. Raw data for crayfish sampling at Lake Tahoe from 2008-2014 at multiple locations. At each location, two traps were utilized in case of trap loss and placed overnight at discrete depths (3, 5, 10, 20, 30, 40, 50 m). For all traps, fish were identified and counted and crayfish were counted and gender determined. For some locations and time periods crayfish carapace length and tail muscle samples were also collected for stable isotope analysis.

				Trap A			**Trap B**		
Pull Date	**Location**	**Hours**	**Depth (m)**	**Total**	**Females**	**Males**	**Total**	**Females**	**Males**
30-Jul-08	3rd Creek	19.9	3	0	0	0	43	24	19
30-Jul-08	3rd Creek	19.9	10	97	55	42	90	42	48
30-Jul-08	3rd Creek	19.9	20	35	10	25	0	0	0
30-Jul-08	3rd Creek	19.9	30	9	3	9	16	6	10
30-Jul-08	3rd Creek	19.9	40	0	0	0	6	2	4
30-Jul-08	3rd Creek	19.9	50	5	1	4	5	1	4
26-Sep-08	3rd Creek	24.5	3	36	0	0	0	0	0
26-Sep-08	3rd Creek	24.5	10	104	0	0	0	0	0
26-Sep-08	3rd Creek	24.5	20	71	0	0	94	0	0
26-Sep-08	3rd Creek	24.5	30	53	0	0	42	0	0
26-Sep-08	3rd Creek	24.5	40	34	0	0	15	0	0
26-Sep-08	3rd Creek	24.5	50	10	0	0	11	0	0
7-Nov-08	3rd Creek	NA	3	NA	NA	NA	NA	NA	NA
7-Nov-08	3rd Creek	NA	10	NA	NA	NA	NA	NA	NA
7-Nov-08	3rd Creek	NA	20	NA	NA	NA	NA	NA	NA
7-Nov-08	3rd Creek	NA	30	NA	NA	NA	NA	NA	NA
7-Nov-08	3rd Creek	NA	40	NA	NA	NA	NA	NA	NA
7-Nov-08	3rd Creek	NA	50	NA	NA	NA	NA	NA	NA
23-Jul-08	Baldwin Creek	19.4	3	21	9	12	14	6	8
23-Jul-08	Baldwin Creek	19.4	10	29	15	14	8	6	2
23-Jul-08	Baldwin Creek	19.4	20	0	0	0	0	0	0
23-Jul-08	Baldwin Creek	19.4	30	0	0	0	0	0	0
23-Jul-08	Baldwin Creek	19.4	40	NA	NA	NA	NA	NA	NA
23-Jul-08	Baldwin Creek	19.4	50	0	0	0	0	0	0
13-Nov-08	Baldwin Creek	24.5	3	NA	NA	NA	NA	NA	NA
13-Nov-08	Baldwin Creek	24.4	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Baldwin Creek	24.3	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Baldwin Creek	24.2	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Baldwin Creek	24.1	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Baldwin Creek	24.0	50	NA	NA	NA	NA	NA	NA
30-Jul-08	Carnelian Bay	20.2	3	92	56	36	66	63	3
30-Jul-08	Carnelian Bay	20.2	10	96	50	46	62	43	19
30-Jul-08	Carnelian Bay	20.2	20	53	25	28	87	37	50
30-Jul-08	Carnelian Bay	20.2	30	61	24	37	68	28	40
30-Jul-08	Carnelian Bay	20.2	40	43	21	22	29	14	15
30-Jul-08	Carnelian Bay	20.2	50	6	4	2	27	13	14
26-Sep-08	Carnelian Bay	24.6	3	0	0	0	0	0	0
26-Sep-08	Carnelian Bay	24.6	10	87	0	0	0	0	0
26-Sep-08	Carnelian Bay	24.6	20	109	0	0	103	0	0
26-Sep-08	Carnelian Bay	24.6	30	107	0	0	110	0	0
26-Sep-08	Carnelian Bay	24.6	40	78	0	0	66	0	0
26-Sep-08	Carnelian Bay	24.6	50	42	0	0	38	0	0
13-Nov-08	Carnelian Bay	21.2	3	NA	NA	NA	NA	NA	NA

13-Nov-08	Carnelian Bay	21.2	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Carnelian Bay	21.2	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Carnelian Bay	21.2	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Carnelian Bay	21.1	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Carnelian Bay	21.2	50	NA	NA	NA	NA	NA	NA
29-Jul-08	Cave Rock	21.0	3	47	21	26	42	21	21
29-Jul-08	Cave Rock	21.0	10	NA	NA	NA	NA	NA	NA
29-Jul-08	Cave Rock	21.0	20	90	51	39	90	47	43
29-Jul-08	Cave Rock	21.0	30	70	27	43	63	26	37
29-Jul-08	Cave Rock	21.0	40	0	0	0	0	0	0
29-Jul-08	Cave Rock	21.0	50	85	39	46	70	24	46
13-Nov-08	Cave Rock	21.6	3	NA	NA	NA	NA	NA	NA
13-Nov-08	Cave Rock	21.6	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Cave Rock	21.4	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Cave Rock	21.3	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Cave Rock	21.1	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Cave Rock	21.0	50	NA	NA	NA	NA	NA	NA
5-Jun-08	Crystal Bay	21.1	3	28	0	0	30	0	0
5-Jun-08	Crystal Bay	21.1	10	10	5	5	3	2	1
5-Jun-08	Crystal Bay	21.1	20	16	6	10	31	14	17
5-Jun-08	Crystal Bay	21.1	30	25	9	16	44	19	25
5-Jun-08	Crystal Bay	21.1	40	NA	NA	NA	NA	NA	NA
5-Jun-08	Crystal Bay	21.1	50	0	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	3	0	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	10	0	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	20	0	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	30	0	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	40	6	0	0	0	0	0
22-Jul-08	Crystal Bay	22.2	50	0	0	0	0	0	0
2-Sep-08	Crystal Bay	15.1	3	54	24	30	49	25	24
2-Sep-08	Crystal Bay	15.1	10	88	47	41	19	10	9
2-Sep-08	Crystal Bay	15.1	20	90	40	50	109	67	42
2-Sep-08	Crystal Bay	15.1	30	15	5	10	3	1	2
2-Sep-08	Crystal Bay	15.1	40	2	2	0	0	0	0
2-Sep-08	Crystal Bay	15.1	50	2	2	0	0	0	0
7-Nov-08	Crystal Bay	NA	3	11	3	8	9	4	5
7-Nov-08	Crystal Bay	NA	10	77	47	30	49	33	16
7-Nov-08	Crystal Bay	NA	20	88	60	28	81	43	38
7-Nov-08	Crystal Bay	NA	30	29	14	15	33	20	13
7-Nov-08	Crystal Bay	NA	40	10	6	4	9	8	1
7-Nov-08	Crystal Bay	NA	50	2	2	0	15	6	9
23-Jul-08	Homewood	17.9	3	0	0	0	0	0	0
23-Jul-08	Homewood	17.9	10	0	0	0	0	0	0
23-Jul-08	Homewood	17.9	20	16	9	7	28	20	8
23-Jul-08	Homewood	17.9	30	4	2	2	0	0	0
23-Jul-08	Homewood	17.9	40	0	0	0	0	0	0
23-Jul-08	Homewood	17.9	50	1	1	0	0	0	0
13-Nov-08	Homewood	21.5	3	NA	NA	NA	NA	NA	NA
13-Nov-08	Homewood	21.5	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Homewood	21.4	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Homewood	21.3	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Homewood	21.2	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Homewood	21.1	50	NA	NA	NA	NA	NA	NA
23-Jul-08	Kings Beach	20.6	3	0	0	0	0	0	0
23-Jul-08	Kings Beach	20.6	10	0	0	0	0	0	0
23-Jul-08	Kings Beach	20.6	20	0	0	0	0	0	0
23-Jul-08	Kings Beach	20.6	30	NA	NA	NA	NA	NA	NA
23-Jul-08	Kings Beach	20.6	40	NA	NA	NA	NA	NA	NA
23-Jul-08	Kings Beach	20.6	50	0	0	0	0	0	0
26-Sep-08	Kings Beach	23.8	3	93	0	0	0	0	0
26-Sep-08	Kings Beach	23.8	10	90	0	0	0	0	0
26-Sep-08	Kings Beach	23.8	20	125	0	0	103	0	0
26-Sep-08	Kings Beach	23.8	30	NA	NA	NA	NA	NA	NA
26-Sep-08	Kings Beach	23.8	40	68	0	0	55	0	0

26-Sep-08	Kings Beach	23.8	50	17	0	0	28	0	0
7-Nov-08	Kings Beach	NA	3	NA	NA	NA	NA	NA	NA
7-Nov-08	Kings Beach	NA	10	NA	NA	NA	NA	NA	NA
7-Nov-08	Kings Beach	NA	20	NA	NA	NA	NA	NA	NA
7-Nov-08	Kings Beach	NA	30	NA	NA	NA	NA	NA	NA
7-Nov-08	Kings Beach	NA	40	NA	NA	NA	NA	NA	NA
7-Nov-08	Kings Beach	NA	50	NA	NA	NA	NA	NA	NA
30-Jul-08	Sand Harbor	19.8	3	90	60	30	61	30	31
30-Jul-08	Sand Harbor	19.8	10	83	42	41	108	63	45
30-Jul-08	Sand Harbor	19.8	20	80	41	39	76	39	37
30-Jul-08	Sand Harbor	19.8	30	67	26	41	65	25	40
30-Jul-08	Sand Harbor	19.8	40	17	6	11	23	13	10
30-Jul-08	Sand Harbor	19.8	50	18	7	11	17	10	7
26-Sep-08	Sand Harbor	24.4	3	1	0	0	0	0	0
26-Sep-08	Sand Harbor	24.4	10	1	0	0	0	0	0
26-Sep-08	Sand Harbor	24.4	20	97	0	0	78	0	0
26-Sep-08	Sand Harbor	24.4	30	61	0	0	59	0	0
26-Sep-08	Sand Harbor	24.4	40	20	0	0	2	0	0
26-Sep-08	Sand Harbor	24.4	50	20	0	0	16	0	0
7-Nov-08	Sand Harbor	NA	3	NA	NA	NA	NA	NA	NA
7-Nov-08	Sand Harbor	NA	10	NA	NA	NA	NA	NA	NA
7-Nov-08	Sand Harbor	NA	20	NA	NA	NA	NA	NA	NA
7-Nov-08	Sand Harbor	NA	30	NA	NA	NA	NA	NA	NA
7-Nov-08	Sand Harbor	NA	40	NA	NA	NA	NA	NA	NA
7-Nov-08	Sand Harbor	NA	50	NA	NA	NA	NA	NA	NA
30-Jul-08	Secret Harbor	20.8	3	66	37	29	66	25	41
30-Jul-08	Secret Harbor	20.8	10	77	40	37	113	70	43
30-Jul-08	Secret Harbor	20.8	20	93	41	52	100	50	50
30-Jul-08	Secret Harbor	20.8	30	NA	NA	NA	NA	NA	NA
30-Jul-08	Secret Harbor	20.8	40	47	12	35	51	17	34
30-Jul-08	Secret Harbor	20.8	50	25	9	16	28	12	16
26-Sep-08	Secret Harbor	24.2	3	50	0	0	0	0	0
26-Sep-08	Secret Harbor	24.2	10	95	0	0	0	0	0
26-Sep-08	Secret Harbor	24.2	20	88	0	0	81	0	0
26-Sep-08	Secret Harbor	24.2	30	51	0	0	87	0	0
26-Sep-08	Secret Harbor	24.2	40	1	0	0	1	0	0
26-Sep-08	Secret Harbor	24.2	50	12	0	0	0	0	0
7-Nov-08	Secret Harbor	NA	3	NA	NA	NA	NA	NA	NA
7-Nov-08	Secret Harbor	NA	10	NA	NA	NA	NA	NA	NA
7-Nov-08	Secret Harbor	NA	20	NA	NA	NA	NA	NA	NA
7-Nov-08	Secret Harbor	NA	30	NA	NA	NA	NA	NA	NA
7-Nov-08	Secret Harbor	NA	40	NA	NA	NA	NA	NA	NA
7-Nov-08	Secret Harbor	NA	50	NA	NA	NA	NA	NA	NA
23-Jul-08	Sugar Pine Point	19.8	3	74	44	30	50	26	24
23-Jul-08	Sugar Pine Point	19.8	10	0	98	68	95	50	45
23-Jul-08	Sugar Pine Point	19.8	20	72	41	31	46	26	20
23-Jul-08	Sugar Pine Point	19.8	30	NA	NA	NA	NA	NA	NA
23-Jul-08	Sugar Pine Point	19.8	40	NA	NA	NA	NA	NA	NA
23-Jul-08	Sugar Pine Point	19.8	50	NA	NA	NA	NA	NA	NA
2-Sep-08	Sugar Pine Point	15.1	3	0	0	0	0	0	0
2-Sep-08	Sugar Pine Point	15.1	10	0	0	0	0	0	0
2-Sep-08	Sugar Pine Point	15.1	20	0	0	0	15	11	4
2-Sep-08	Sugar Pine Point	15.1	30	0	0	0	0	0	0
2-Sep-08	Sugar Pine Point	15.1	40	70	29	41	0	0	0
2-Sep-08	Sugar Pine	15.1	50	0	0	0	0	0	0

	Point								
13-Nov-08	Sugar Pine Point	21.7	3	31	18	13	27	11	16
13-Nov-08	Sugar Pine Point	21.6	10	60	22	38	68	20	48
13-Nov-08	Sugar Pine Point	21.5	20	74	21	53	57	20	37
13-Nov-08	Sugar Pine Point	21.3	30	33	8	25	43	10	33
13-Nov-08	Sugar Pine Point	21.3	40	14	4	10	22	4	18
13-Nov-08	Sugar Pine Point	21.1	50	17	2	15	13	6	7
22-Jul-08	Sunnyside	26.7	3	40	25	15	28	13	15
22-Jul-08	Sunnyside	26.7	10	51	31	20	73	39	34
22-Jul-08	Sunnyside	26.7	20	0	0	0	0	0	0
22-Jul-08	Sunnyside	26.7	30	NA	NA	NA	NA	NA	NA
22-Jul-08	Sunnyside	26.7	40	47	21	26	25	9	16
22-Jul-08	Sunnyside	26.7	50	NA	NA	NA	NA	NA	NA
2-Sep-08	Sunnyside	14.9	3	35	23	12	0	0	0
2-Sep-08	Sunnyside	14.9	10	0	0	0	0	0	0
2-Sep-08	Sunnyside	14.9	20	41	23	18	51	29	22
2-Sep-08	Sunnyside	14.9	30	53	29	24	44	28	16
2-Sep-08	Sunnyside	14.9	40	21	14	7	28	16	12
2-Sep-08	Sunnyside	14.9	50	10	6	4	0	0	0
13-Nov-08	Sunnyside	21.6	3	14	5	9	35	8	27
13-Nov-08	Sunnyside	21.5	10	44	23	21	31	12	19
13-Nov-08	Sunnyside	21.4	20	38	15	23	25	7	18
13-Nov-08	Sunnyside	21.3	30	46	22	24	36	15	21
13-Nov-08	Sunnyside	21.2	40	34	22	12	44	19	25
13-Nov-08	Sunnyside	21.1	50	30	7	23	20	6	14
18-Jun-08	Sunnyside	22.0	3	1	0	1	11	6	5
18-Jun-08	Sunnyside	22.0	10	11	4	7	11	6	5
18-Jun-08	Sunnyside	22.0	20	11	2	9	2	1	1
18-Jun-08	Sunnyside	22.0	30	5	3	2	0	0	0
18-Jun-08	Sunnyside	22.0	40	NA	NA	NA	NA	NA	NA
18-Jun-08	Sunnyside	22.0	50	7	2	5	3	1	2
18-Jun-08	Tahoe City	21.8	3	15	6	9	10	7	3
18-Jun-08	Tahoe City	21.8	10	16	7	9	16	6	10
18-Jun-08	Tahoe City	21.8	20	40	20	20	30	11	19
18-Jun-08	Tahoe City	21.8	30	20	11	9	6	4	2
18-Jun-08	Tahoe City	21.8	40	20	8	12	24	11	13
18-Jun-08	Tahoe City	21.8	50	10	5	5	8	3	5
22-Jul-08	Tahoe City	27.2	3	NA	NA	NA	NA	NA	NA
22-Jul-08	Tahoe City	27.2	10	0	0	0	0	0	0
22-Jul-08	Tahoe City	27.2	20	0	0	0	0	0	0
22-Jul-08	Tahoe City	27.2	30	0	0	0	0	0	0
22-Jul-08	Tahoe City	27.2	40	NA	NA	NA	NA	NA	NA
22-Jul-08	Tahoe City	27.2	50	0	0	0	0	0	0
2-Sep-08	Tahoe City	15.2	3	57	35	22	86	55	31
2-Sep-08	Tahoe City	15.2	10	130	91	39	0	0	0
2-Sep-08	Tahoe City	15.2	20	104	68	36	29	20	9
2-Sep-08	Tahoe City	15.2	30	98	62	36	75	41	34
2-Sep-08	Tahoe City	15.2	40	50	21	29	62	37	25
2-Sep-08	Tahoe City	15.2	50	24	16	8	30	19	11
13-Nov-08	Tahoe City	21.5	3	54	24	30	42	17	25
13-Nov-08	Tahoe City	21.6	10	85	34	51	62	21	41
13-Nov-08	Tahoe City	21.3	20	80	10	70	56	6	50
13-Nov-08	Tahoe City	21.1	30	66	16	50	61	14	47
13-Nov-08	Tahoe City	21.0	40	65	19	46	66	26	40
13-Nov-08	Tahoe City	20.9	50	44	7	37	39	18	21
29-Jul-08	Tahoe Keys	21.3	3	0	0	0	0	0	0
29-Jul-08	Tahoe Keys	21.3	10	0	0	0	0	0	0
29-Jul-08	Tahoe Keys	21.3	20	0	0	0	0	0	0
29-Jul-08	Tahoe Keys	21.3	30	NA	NA	NA	NA	NA	NA

29-Jul-08	Tahoe Keys	21.3	40	0	0	0	0	0	0
29-Jul-08	Tahoe Keys	21.3	50	0	0	0	0	0	0
13-Nov-08	Tahoe Keys	23.7	3	NA	NA	NA	NA	NA	NA
13-Nov-08	Tahoe Keys	23.6	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Tahoe Keys	23.5	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Tahoe Keys	23.4	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Tahoe Keys	23.3	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Tahoe Keys	23.2	50	NA	NA	NA	NA	NA	NA
29-Jul-08	Zephyr Cove	21.3	3	65	31	34	85	42	43
29-Jul-08	Zephyr Cove	21.3	10	100	47	53	103	46	57
29-Jul-08	Zephyr Cove	21.3	20	0	0	0	0	0	0
29-Jul-08	Zephyr Cove	21.3	30	70	20	50	68	31	37
29-Jul-08	Zephyr Cove	21.3	40	0	0	0	21	9	12
29-Jul-08	Zephyr Cove	21.3	50	0	0	0	0	0	0
13-Nov-08	Zephyr Cove	22.6	3	NA	NA	NA	NA	NA	NA
13-Nov-08	Zephyr Cove	22.5	10	NA	NA	NA	NA	NA	NA
13-Nov-08	Zephyr Cove	22.4	20	NA	NA	NA	NA	NA	NA
13-Nov-08	Zephyr Cove	22.3	30	NA	NA	NA	NA	NA	NA
13-Nov-08	Zephyr Cove	22.2	40	NA	NA	NA	NA	NA	NA
13-Nov-08	Zephyr Cove	22.1	50	NA	NA	NA	NA	NA	NA
8-May-09	3rd Creek	23.9	3	0	NA	NA	0	NA	NA
8-May-09	3rd Creek	23.8	10	0	NA	NA	0	NA	NA
8-May-09	3rd Creek	23.8	20	0	NA	NA	0	NA	NA
8-May-09	3rd Creek	23.8	30	1	1	NA	NA	NA	NA
8-May-09	3rd Creek	23.8	40	1	1	NA	NA	NA	NA
8-May-09	3rd Creek	23.5	50	NA	NA	NA	NA	NA	NA
4-Jun-09	3rd Creek	22.6	3	0	0	0	0	0	0
4-Jun-09	3rd Creek	22.5	10	10	1	9	18	7	11
4-Jun-09	3rd Creek	22.3	20	4	0	4	2	1	1
4-Jun-09	3rd Creek	22.3	30	1	0	1	0	0	0
4-Jun-09	3rd Creek	22.2	40	1	0	1	1	0	1
4-Jun-09	3rd Creek	22.1	50	1	0	1	0	0	0
24-Jun-09	3rd Creek	23.3	3	4	4	0	3	3	0
24-Jun-09	3rd Creek	23.1	10	15	8	7	18	15	3
24-Jun-09	3rd Creek	23.1	20	3	3	0	0	0	0
24-Jun-09	3rd Creek	23.0	30	1	0	1	1	1	0
24-Jun-09	3rd Creek	23.0	40	0	0	0	0	0	0
24-Jun-09	3rd Creek	22.8	50	1	1	0	2	2	0
7-May-09	Baldwin Creek	20.2	3	0	NA	NA	0	NA	NA
7-May-09	Baldwin Creek	20.3	10	0	NA	NA	0	NA	NA
7-May-09	Baldwin Creek	20.3	20	NA	NA	NA	NA	NA	NA
7-May-09	Baldwin Creek	20.2	30	0	NA	NA	0	NA	NA
7-May-09	Baldwin Creek	20.2	40	NA	NA	NA	NA	NA	NA
7-May-09	Baldwin Creek	20.2	50	NA	NA	NA	NA	NA	NA
2-Jun-09	Baldwin Creek	21.5	3	0	0	0	0	0	0
2-Jun-09	Baldwin Creek	21.2	10	0	0	0	0	0	0
2-Jun-09	Baldwin Creek	21.1	20	0	0	0	1	1	0
2-Jun-09	Baldwin Creek	20.9	30	1	1	0	0	0	0
2-Jun-09	Baldwin Creek	20.8	40	0	0	0	0	0	0
2-Jun-09	Baldwin Creek	20.8	50	0	0	0	0	0	0
24-Jun-09	Baldwin Creek	21.4	3	2	2	0	2	2	0
24-Jun-09	Baldwin Creek	21.2	10	0	0	0	0	0	0
24-Jun-09	Baldwin Creek	21.1	20	0	0	0	0	0	0
24-Jun-09	Baldwin Creek	21.1	30	1	1	0	0	0	0
24-Jun-09	Baldwin Creek	21.0	40	0	0	0	0	0	0
24-Jun-09	Baldwin Creek	20.9	50	0	0	0	0	0	0
22-Jul-09	Baldwin Creek	NA	3	NA	NA	NA	NA	NA	NA
22-Jul-09	Baldwin Creek	19.6	10	16	5	11	14	9	5
22-Jul-09	Baldwin Creek	19.5	20	2	2	0	3	3	0
22-Jul-09	Baldwin Creek	19.3	30	3	3	0	2	0	2
22-Jul-09	Baldwin Creek	19.3	40	1	0	1	0	0	0
22-Jul-09	Baldwin Creek	19.2	50	0	0	0	0	0	0
8-May-09	Carnelian Bay	91.3	3	23	12	11	3	1	2
8-May-09	Carnelian Bay	91.2	10	23	6	17	21	9	12

8-May-09	Carnelian Bay	91.1	20	52	22	30	47	25	22
8-May-09	Carnelian Bay	91.0	30	6	0	6	30	9	21
8-May-09	Carnelian Bay	90.9	40	24	8	16	10	4	6
8-May-09	Carnelian Bay	90.9	50	NA	NA	NA	NA	NA	NA
4-Jun-09	Carnelian Bay	49.6	3	14	6	8	0	0	0
4-Jun-09	Carnelian Bay	49.4	10	23	6	17	26	12	14
4-Jun-09	Carnelian Bay	49.3	20	19	8	11	48	21	27
4-Jun-09	Carnelian Bay	49.2	30	21	10	11	21	9	11
4-Jun-09	Carnelian Bay	49.0	40	18	6	12	21	7	14
4-Jun-09	Carnelian Bay	48.9	50	7	2	5	9	4	5
25-Jun-09	Carnelian Bay	23.7	3	27	13	14	42	17	25
25-Jun-09	Carnelian Bay	23.5	10	15	6	9	16	8	8
25-Jun-09	Carnelian Bay	23.3	20	52	23	29	45	23	22
25-Jun-09	Carnelian Bay	23.1	30	33	19	14	37	20	17
25-Jun-09	Carnelian Bay	22.9	40	10	6	4	16	6	10
25-Jun-09	Carnelian Bay	22.8	50	14	10	4	12	10	2
3-Nov-09	Carnelian Bay	25.4	3	5	3	2	8	3	5
3-Nov-09	Carnelian Bay	25.3	10	40	9	31	66	29	37
3-Nov-09	Carnelian Bay	25.1	20	87	42	45	88	39	49
3-Nov-09	Carnelian Bay	25.0	30	86	21	65	85	39	46
3-Nov-09	Carnelian Bay	24.8	40	65	24	41	77	33	44
3-Nov-09	Carnelian Bay	24.7	50	31	17	14	Half Open	NA	NA
7-May-09	Cave Rock	20.4	3	2	NA	2	NA	NA	NA
7-May-09	Cave Rock	20.2	10	1	NA	1	NA	NA	NA
7-May-09	Cave Rock	20.5	20	3	NA	3	8	2	6
7-May-09	Cave Rock	20.5	30	1	1	NA	4	NA	4
7-May-09	Cave Rock	20.5	40	2	NA	2	1	NA	1
7-May-09	Cave Rock	20.5	50	NA	NA	NA	2	1	1
2-Jun-09	Cave Rock	22.0	3	2	0	2	8	0	8
2-Jun-09	Cave Rock	21.9	10	5	3	2	6	3	3
2-Jun-09	Cave Rock	21.8	20	7	4	3	8	0	8
2-Jun-09	Cave Rock	21.7	30	1	1	0	2	2	0
2-Jun-09	Cave Rock	21.6	40	0	0	0	0	0	0
2-Jun-09	Cave Rock	21.5	50	1	1	0	1	1	0
23-Jun-09	Cave Rock	27.6	3	2	1	1	8	3	5
23-Jun-09	Cave Rock	27.3	10	80	42	38	105	56	49
23-Jun-09	Cave Rock	27.1	20	41	25	16	44	26	18
23-Jun-09	Cave Rock	27.0	30	32	18	14	4	2	2
23-Jun-09	Cave Rock	26.9	40	7	2	5	3	0	3
23-Jun-09	Cave Rock	26.7	50	9	7	2	6	3	3
22-Jul-09	Cave Rock	17.3	3	45	24	21	62	31	31
22-Jul-09	Cave Rock	17.4	10	84	48	36	99	60	39
22-Jul-09	Cave Rock	17.7	20	moved	NA	NA	81	32	49
22-Jul-09	Cave Rock	17.8	30	23	14	9	28	12	16
22-Jul-09	Cave Rock	17.8	40	22	10	12	9	5	4
22-Jul-09	Cave Rock	17.9	50	28	10	18	4	3	1
8-May-09	Crystal Bay	23.5	3	1	NA	1	1	1	0
8-May-09	Crystal Bay	23.6	10	3	NA	3	2	1	1
8-May-09	Crystal Bay	23.6	20	10	NA	10	10	4	6
8-May-09	Crystal Bay	23.8	30	1	NA	1	3	2	1
8-May-09	Crystal Bay	23.8	40	NA	NA	NA	NA	NA	NA
8-May-09	Crystal Bay	23.8	50	NA	NA	NA	NA	NA	NA
4-Jun-09	Crystal Bay	24.7	3	16	4	12	6	0	6
4-Jun-09	Crystal Bay	25.3	10	75	20	55	72	35	37
4-Jun-09	Crystal Bay	24.9	20	67	32	35	34	15	19
4-Jun-09	Crystal Bay	24.6	30	14	5	9	21	6	15
4-Jun-09	Crystal Bay	24.5	40	NA	NA	NA	NA	NA	NA
4-Jun-09	Crystal Bay	24.5	50	0	0	0	0	0	0
22-Jul-09	Crystal Bay	22.4	3	28	15	13	50	25	25
22-Jul-09	Crystal Bay	22.2	10	74	32	42	51	26	25
22-Jul-09	Crystal Bay	22.0	20	73	37	36	84	37	47
22-Jul-09	Crystal Bay	21.9	30	18	10	8	38	20	18

22-Jul-09	Crystal Bay	21.8	40	11	4	7	16	10	6
22-Jul-09	Crystal Bay	21.7	50	6	5	1	5	0	5
20-Oct-09	Crystal Bay	67.9	3	28	12	16	68	24	34
20-Oct-09	Crystal Bay	67.5	10	47	26	21	72	49	23
20-Oct-09	Crystal Bay	67.4	20	67	43	24	76	46	30
20-Oct-09	Crystal Bay	67.3	30	68	48	20	108	70	38
20-Oct-09	Crystal Bay	67.2	40	25	14	11	35	15	20
20-Oct-09	Crystal Bay	67.1	50	15	8	7	0	0	0
12-May-09	Homewood/Obexier's	23.2	3	0	0	0	1	0	1
12-May-09	Homewood/Obexier's	23.1	10	1	0	1	3	2	1
12-May-09	Homewood/Obexier's	23.1	20	1	1	0	3	2	1
12-May-09	Homewood/Obexier's	23.0	30	4	2	2	0	0	0
12-May-09	Homewood/Obexier's	22.8	40	0	0	0	0	0	0
12-May-09	Homewood/Obexier's	22.8	50	0	0	0	0	0	0
12-Jun-09	Homewood/Obexier's	21.4	3	26	10	16	15	4	11
12-Jun-09	Homewood/Obexier's	21.4	10	7	1	6	12	0	12
12-Jun-09	Homewood/Obexier's	21.3	20	1	0	1	0	0	0
12-Jun-09	Homewood/Obexier's	21.2	30	3	1	2	4	2	2
12-Jun-09	Homewood/Obexier's	21.1	40	0	0	0	1	1	0
12-Jun-09	Homewood/Obexier's	21.0	50	0	0	0	0	0	0
3-Nov-09	Homewood/Obexier's	25.5	3	16	7	9	10	7	3
3-Nov-09	Homewood/Obexier's	25.4	10	4	3	1	3	3	0
3-Nov-09	Homewood/Obexier's	25.4	20	6	5	1	5	2	3
3-Nov-09	Homewood/Obexier's	25.3	30	5	4	1	5	3	2
3-Nov-09	Homewood/Obexier's	25.2	40	6	3	3	11	5	6
3-Nov-09	Homewood/Obexier's	25.1	50	2	0	2	7	3	4
8-May-09	Kings Beach	23.8	3	18	12	6	18	8	10
8-May-09	Kings Beach	23.9	10	2	2	NA	3	3	0
8-May-09	Kings Beach	23.9	20	15	9	6	28	18	10
8-May-09	Kings Beach	23.8	30	16	4	12	38	8	30
8-May-09	Kings Beach	23.8	40	4	1	3	6	1	5
8-May-09	Kings Beach	23.8	50	10	0	10	8	0	8
4-Jun-09	Kings Beach	20.5	3	48	14	34	57	24	33
4-Jun-09	Kings Beach	22.5	10	34	18	16	36	11	25
4-Jun-09	Kings Beach	22.3	20	43	24	19	40	15	25
4-Jun-09	Kings Beach	22.1	30	37	10	27	4	1	3
4-Jun-09	Kings Beach	22.1	40	24	4	20	10	3	7
4-Jun-09	Kings Beach	21.9	50	20	5	15	12	4	8
25-Jun-09	Kings Beach	21.9	3	94	38	56	92	36	56
25-Jun-09	Kings Beach	21.7	10	67	40	27	24	9	15
25-Jun-09	Kings Beach	21.6	20	32	16	16	17	9	8
25-Jun-09	Kings Beach	21.1	30	50	19	31	43	15	28
25-Jun-09	Kings Beach	21.0	40	21	8	13	0	0	0
25-Jun-09	Kings Beach	20.8	50	17	10	7	6	1	5
3-Nov-09	Kings Beach	25.1	3	57	19	38	73	21	52
3-Nov-09	Kings Beach	24.9	10	23	9	14	39	12	27
3-Nov-09	Kings Beach	24.7	20	81	40	41	77	45	32
3-Nov-09	Kings Beach	24.5	30	83	48	35	68	40	28
3-Nov-09	Kings Beach	24.3	40	78	41	37	73	32	41

3-Nov-09	Kings Beach	24.2	50	40	21	19	20	12	8
8-May-09	Sand Harbour	23.6	3	0	NA	NA	0	NA	NA
8-May-09	Sand Harbour	23.6	10	3	2	1	0	NA	NA
8-May-09	Sand Harbour	23.7	20	3	2	1	4	1	3
8-May-09	Sand Harbour	23.7	30	2	1	NA	1	1	NA
8-May-09	Sand Harbour	23.7	40	NA	NA	NA	NA	NA	NA
8-May-09	Sand Harbour	23.7	50	NA	NA	NA	1	NA	1
3-Jun-09	Sand Harbour	23.4	3	2	1	1	0	0	0
3-Jun-09	Sand Harbour	23.3	10	10	6	4	6	4	2
3-Jun-09	Sand Harbour	23.1	20	14	6	8	11	5	6
3-Jun-09	Sand Harbour	23.1	30	5	3	2	6	4	2
3-Jun-09	Sand Harbour	22.9	40	7	3	4	5	1	4
3-Jun-09	Sand Harbour	22.8	50	NA	NA	NA	NA	NA	NA
23-Jun-09	Sand Harbour	24.8	3	0	NA	NA	0	NA	NA
23-Jun-09	Sand Harbour	24.7	10	13	6	7	27	10	17
23-Jun-09	Sand Harbour	NA	20	NA	NA	NA	NA	NA	NA
23-Jun-09	Sand Harbour	NA	30	NA	NA	NA	NA	NA	NA
23-Jun-09	Sand Harbour	NA	40	NA	NA	NA	NA	NA	NA
23-Jun-09	Sand Harbour	NA	50	NA	NA	NA	NA	NA	NA
7-May-09	Secret Harbor	20.5	3	2	NA	2	0	NA	NA
7-May-09	Secret Harbor	20.5	10	2	1	1	1	1	NA
7-May-09	Secret Harbor	20.6	20	4	2	2	10	2	8
7-May-09	Secret Harbor	20.7	30	3	1	2	9	4	5
7-May-09	Secret Harbor	20.6	40	1	1	NA	4	3	1
7-May-09	Secret Harbor	20.9	50	NA	NA	NA	NA	NA	NA
3-Jun-09	Secret Harbor	23.7	3	26	8	18	28	9	19
3-Jun-09	Secret Harbor	23.0	10	10	6	4	3	0	3
3-Jun-09	Secret Harbor	22.9	20	3	2	1	8	3	5
3-Jun-09	Secret Harbor	22.8	30	11	4	7	0	0	0
3-Jun-09	Secret Harbor	NA	40	NA	NA	NA	NA	NA	NA
3-Jun-09	Secret Harbor	NA	50	NA	NA	NA	NA	NA	NA
23-Jun-09	Secret Harbor	26.2	3	8	5	3	6	4	2
23-Jun-09	Secret Harbor	26.0	10	37	23	14	37	24	13
23-Jun-09	Secret Harbor	25.8	20	36	25	11	69	42	27
23-Jun-09	Secret Harbor	25.6	30	11	6	5	31	26	5
23-Jun-09	Secret Harbor	25.5	40	15	3	12	15	7	8
23-Jun-09	Secret Harbor	25.3	50	11	6	5	0	NA	NA
12-May-09	Sugar Pine Point	23.3	3	3	2	1	1	0	1
12-May-09	Sugar Pine Point	23.2	10	2	1	1	6	3	3
12-May-09	Sugar Pine Point	23.0	20	0	0	0	NA	NA	NA
12-May-09	Sugar Pine Point	NA	30	NA	NA	NA	0	0	0
12-May-09	Sugar Pine Point	22.8	40	1	1	0	1	0	1
12-May-09	Sugar Pine Point	22.7	50	0	0	0	0	0	0
12-Jun-09	Sugar Pine Point	21.3	3	4	0	4	4	0	4
12-Jun-09	Sugar Pine Point	21.2	10	15	3	12	16	4	12
12-Jun-09	Sugar Pine Point	NA	20	NA	NA	NA	NA	NA	NA
12-Jun-09	Sugar Pine Point	21.0	30	4	0	4	1	0	1
12-Jun-09	Sugar Pine Point	21.0	40	2	1	1	3	2	1
12-Jun-09	Sugar Pine Point	20.9	50	5	5	0	0	0	0
22-Jul-09	Sugar Pine Point	26.6	3	39	23	16	21	11	10
22-Jul-09	Sugar Pine Point	26.6	10	93	49	44	119	68	51
22-Jul-09	Sugar Pine	26.4	20	60	29	31	62	26	36

	Point								
22-Jul-09	Sugar Pine Point	26.3	30	26	13	13	11	6	5
22-Jul-09	Sugar Pine Point	26.2	40	9	6	3	4	3	1
22-Jul-09	Sugar Pine Point	26.1	50	14	11	3	2	2	0
3-Nov-09	Sugar Pine Point	25.7	3	15	6	9	16	8	8
3-Nov-09	Sugar Pine Point	25.5	10	68	28	40	50	29	21
3-Nov-09	Sugar Pine Point	25.3	20	66	29	37	52	26	26
3-Nov-09	Sugar Pine Point	25.2	30	13	6	7	14	5	9
3-Nov-09	Sugar Pine Point	25.2	40	12	5	7	10	4	6
3-Nov-09	Sugar Pine Point	25.0	50	20	6	14	11	6	5
12-May-09	Sunnyside	23.2	3	1	0	1	1	0	1
12-May-09	Sunnyside	23.0	10	0	0	0	5	2	3
12-May-09	Sunnyside	23.1	20	1	0	1	0	0	0
12-May-09	Sunnyside	22.8	30	1	1	0	2	0	2
12-May-09	Sunnyside	22.7	40	3	1	2	0	0	0
12-May-09	Sunnyside	22.7	50	1	0	1	6	2	4
12-Jun-09	Sunnyside	21.5	3	38	18	20	41	14	27
12-Jun-09	Sunnyside	21.4	10	21	7	14	13	8	5
12-Jun-09	Sunnyside	21.4	20	3	0	3	15	7	8
12-Jun-09	Sunnyside	21.2	30	11	6	5	13	3	10
12-Jun-09	Sunnyside	21.1	40	2	0	2	3	1	2
12-Jun-09	Sunnyside	21.1	50	0	0	0	7	6	1
22-Jul-09	Sunnyside	25.6	3	49	22	27	43	23	20
22-Jul-09	Sunnyside	25.4	10	73	49	24	53	30	23
22-Jul-09	Sunnyside	25.2	20	141	19	NA	4	1	3
22-Jul-09	Sunnyside	25.1	30	44	27	17	Lost Trap	NA	NA
22-Jul-09	Sunnyside	25.2	40	20	11	9	14	9	5
22-Jul-09	Sunnyside	24.9	50	5	3	2	5	4	1
20-Oct-09	Sunnyside	67.8	3	23	11	12	47	31	16
20-Oct-09	Sunnyside	67.7	10	55	41	14	9	5	4
20-Oct-09	Sunnyside	67.6	20	64	47	17	68	56	12
20-Oct-09	Sunnyside	67.5	30	56	45	11	81	59	22
20-Oct-09	Sunnyside	67.3	40	67	39	28	75	54	21
20-Oct-09	Sunnyside	67.2	50	85	58	27	14	10	4
8-May-09	Tahoe City	24.1	3	0	0	0	0	0	0
8-May-09	Tahoe City	24.0	10	5	4	1	6	2	4
8-May-09	Tahoe City	23.9	20	11	3	8	13	7	6
8-May-09	Tahoe City	23.7	30	9	5	4	6	2	4
8-May-09	Tahoe City	23.6	40	7	3	4	7	5	2
8-May-09	Tahoe City	23.5	50	6	5	1	6	4	2
4-Jun-09	Tahoe City	50.7	3	37	11	26	56	37	19
4-Jun-09	Tahoe City	50.3	10	79	28	51	57	27	30
4-Jun-09	Tahoe City	50.1	20	65	29	36	58	32	26
4-Jun-09	Tahoe City	49.7	30	38	13	25	30	17	13
4-Jun-09	Tahoe City	49.4	40	18	8	10	21	7	14
4-Jun-09	Tahoe City	49.1	50	1	1	0	32	20	12
22-Jul-09	Tahoe City	24.1	3	63	33	30	28	11	17
22-Jul-09	Tahoe City	24.1	10	75	39	36	73	NA	36
22-Jul-09	Tahoe City	23.9	20	70	35	35	57	30	27
22-Jul-09	Tahoe City	23.8	30	85	54	31	85	57	28
22-Jul-09	Tahoe City	23.8	40	48	28	20	51	30	21
22-Jul-09	Tahoe City	23.7	50	27	16	11	28	19	9
20-Oct-09	Tahoe City	68.8	3	54	25	29	67	34	33
20-Oct-09	Tahoe City	68.7	10	74	42	32	87	47	40
20-Oct-09	Tahoe City	68.6	20	23	15	8	13	11	2

20-Oct-09	Tahoe City	68.5	30	66	47	19	65	45	20
20-Oct-09	Tahoe City	68.3	40	84	55	29	81	58	23
20-Oct-09	Tahoe City	68.3	50	87	60	27	74	48	26
7-May-09	Tahoe Keys	20.2	3	NA	NA	NA	NA	NA	NA
7-May-09	Tahoe Keys	20.2	10	NA	NA	NA	NA	NA	NA
7-May-09	Tahoe Keys	20.2	20	NA	NA	NA	NA	NA	NA
7-May-09	Tahoe Keys	20.2	30	NA	NA	NA	NA	NA	NA
7-May-09	Tahoe Keys	20.2	40	NA	NA	NA	NA	NA	NA
7-May-09	Tahoe Keys	20.2	50	NA	NA	NA	NA	NA	NA
3-Jun-09	Tahoe Keys	24.2	3	0	0	0	0	0	0
3-Jun-09	Tahoe Keys	23.9	10	1	1	0	0	0	0
3-Jun-09	Tahoe Keys	23.7	20	0	0	0	0	0	0
3-Jun-09	Tahoe Keys	23.7	30	0	0	0	0	0	0
3-Jun-09	Tahoe Keys	23.6	40	0	0	0	0	0	0
3-Jun-09	Tahoe Keys	23.5	50	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	21.4	3	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	21.2	10	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	21.1	20	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	21.0	30	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	21.0	40	0	0	0	0	0	0
24-Jun-09	Tahoe Keys	20.9	50	0	0	0	0	0	0
7-May-09	Zephyr Cove	20.2	3	4	NA	4	4	3	1
7-May-09	Zephyr Cove	20.2	10	8	NA	8	7	NA	7
7-May-09	Zephyr Cove	20.2	20	11	3	5	3	NA	3
7-May-09	Zephyr Cove	20.2	30	5	NA	5	6	NA	6
7-May-09	Zephyr Cove	20.2	40	4	1	3	0	NA	NA
7-May-09	Zephyr Cove	20.2	50	1	1	NA	3	NA	3
2-Jun-09	Zephyr Cove	22.1	3	NA	NA	NA	NA	NA	NA
2-Jun-09	Zephyr Cove	21.9	10	7	1	6	5	2	3
2-Jun-09	Zephyr Cove	21.7	20	12	3	9	0	0	0
2-Jun-09	Zephyr Cove	21.6	30	4	0	4	5	1	4
2-Jun-09	Zephyr Cove	21.5	40	2	0	2	4	2	2
2-Jun-09	Zephyr Cove	21.4	50	NA	NA	NA	NA	NA	NA
23-Jun-09	Zephyr Cove	-55.7	3	10	4	6	15	6	9
23-Jun-09	Zephyr Cove	-56.0	10	48	29	19	54	30	24
23-Jun-09	Zephyr Cove	-56.9	20	30	18	12	1	1	0
23-Jun-09	Zephyr Cove	-57.1	30	13	7	6	14	9	5
23-Jun-09	Zephyr Cove	-57.1	40	12	8	4	8	6	2
23-Jun-09	Zephyr Cove	-57.3	50	16	15	1	5	4	1
27-Jan-10	Baldwin Beach	22.9	3	0	0	0	0	0	0
27-Jan-10	Baldwin Beach	22.8	10	0	0	0	0	0	0
27-Jan-10	Baldwin Beach	22.7	20	1	1	0	1	0	1
27-Jan-10	Baldwin Beach	22.6	30	0	0	0	0	0	0
27-Jan-10	Baldwin Beach	22.5	40	0	0	0	0	0	0
27-Jan-10	Baldwin Beach	22.4	50	0	0	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	3	0	0	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	10	0	0	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	20	1	1	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	30	0	0	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	40	0	0	0	0	0	0
1-Jul-10	Baldwin Beach	21.2	50	0	0	0	0	0	0
5-Aug-10	Baldwin Beach	20.4	3	7	5	2	11	5	6
5-Aug-10	Baldwin Beach	20.3	10	11	7	4	22	14	8
5-Aug-10	Baldwin Beach	20.2	20	3	3	0	1	1	0
5-Aug-10	Baldwin Beach	20.1	30	0	0	0	0	0	0
5-Aug-10	Baldwin Beach	20.1	40	0	0	0	0	0	0
5-Aug-10	Baldwin Beach	20.0	50	0	0	0	0	0	0
15-Sep-10	Baldwin Beach	22.9	3	11	9	2	4	2	2
15-Sep-10	Baldwin Beach	22.8	10	23	16	7	20	15	5
15-Sep-10	Baldwin Beach	22.6	20	13	7	6	14	11	3
15-Sep-10	Baldwin Beach	22.5	30	2	2	0	4	4	0
15-Sep-10	Baldwin Beach	22.5	40	0	0	0	0	0	0
15-Sep-10	Baldwin Beach	22.3	50	0	0	0	0	0	0
9-Feb-10	Carnelian Bay	23.2	3	3	0	3	opened	NA	NA

9-Feb-10	Carnelian Bay	23.0	10	5	3	2	7	4	3
9-Feb-10	Carnelian Bay	23.0	20	9	4	5	14	6	8
9-Feb-10	Carnelian Bay	22.9	30	7	1	6	7	2	5
9-Feb-10	Carnelian Bay	22.8	40	4	0	4	8	0	8
9-Feb-10	Carnelian Bay	22.7	50	20	3	17	18	1	17
2-Feb-10	Cave Rock	20.5	3	0	0	0	1	0	1
2-Feb-10	Cave Rock	20.6	10	1	0	1	1	0	1
2-Feb-10	Cave Rock	20.6	20	0	0	0	1	0	1
2-Feb-10	Cave Rock	20.6	30	4	0	4	8	4	4
2-Feb-10	Cave Rock	20.6	40	12	7	5	0	0	0
2-Feb-10	Cave Rock	20.6	50	5	1	4	3	1	2
1-Jul-10	Cave Rock	19.5	3	0	0	0	3	2	1
1-Jul-10	Cave Rock	19.6	10	4	2	2	4	2	2
1-Jul-10	Cave Rock	19.7	20	5	1	4	4	3	1
1-Jul-10	Cave Rock	19.7	30	1	0	1	0	0	0
1-Jul-10	Cave Rock	19.7	40	0	0	0	0	0	0
1-Jul-10	Cave Rock	19.6	50	0	0	0	0	0	0
5-Aug-10	Cave Rock	23.4	3	21	10	11	14	3	11
5-Aug-10	Cave Rock	23.2	10	105	55	50	6	4	2
5-Aug-10	Cave Rock	23.1	20	97	49	48	84	37	47
5-Aug-10	Cave Rock	22.9	30	64	17	47	62	23	39
5-Aug-10	Cave Rock	22.9	40	31	11	20	22	13	9
5-Aug-10	Cave Rock	22.7	50	17	7	10	6	4	2
15-Sep-10	Cave Rock	21.3	3	11	8	3	31	16	15
15-Sep-10	Cave Rock	21.1	10	103	53	50	60	35	25
15-Sep-10	Cave Rock	21.0	20	79	48	31	69	49	20
15-Sep-10	Cave Rock	20.9	30	53	31	22	57	35	22
15-Sep-10	Cave Rock	20.7	40	7	5	2	12	7	5
15-Sep-10	Cave Rock	20.6	50	12	8	4	10	6	4
9-Feb-10	Crystal Bay	23.1	3	5	3	2	6	4	2
9-Feb-10	Crystal Bay	22.7	10	3	1	2	23	10	13
9-Feb-10	Crystal Bay	22.4	20	11	7	4	4	2	2
9-Feb-10	Crystal Bay	22.1	30	5	4	1	7	1	6
9-Feb-10	Crystal Bay	21.9	40	3	2	1	9	3	6
9-Feb-10	Crystal Bay	21.6	50	8	5	3	7	3	4
3-Jun-10	Crystal Bay	24.6	3	9	2	7	17	6	11
3-Jun-10	Crystal Bay	24.4	10	35	22	13	0	0	0
3-Jun-10	Crystal Bay	24.2	20	26	11	15	20	9	11
3-Jun-10	Crystal Bay	24.1	30	5	3	2	0	0	0
3-Jun-10	Crystal Bay	23.9	40	0	0	0	5	1	4
3-Jun-10	Crystal Bay	23.8	50	3	1	2	0	0	0
30-Jun-10	Crystal Bay	25.7	3	58	15	43	32	14	18
30-Jun-10	Crystal Bay	25.5	10	38	14	24	9	3	6
30-Jun-10	Crystal Bay	25.4	20	53	24	29	51	30	21
30-Jun-10	Crystal Bay	25.2	30	11	5	6	33	14	19
30-Jun-10	Crystal Bay	25.2	40	7	6	1	4	3	1
30-Jun-10	Crystal Bay	25.0	50	5	1	4	5	5	0
4-Aug-10	Crystal Bay	25.2	3	64	25	39	21	10	11
4-Aug-10	Crystal Bay	25.0	10	86	47	39	73	29	44
4-Aug-10	Crystal Bay	24.9	20	91	43	48	75	32	43
4-Aug-10	Crystal Bay	24.8	30	16	6	10	33	19	14
4-Aug-10	Crystal Bay	24.7	40	12	6	6	5	2	3
4-Aug-10	Crystal Bay	24.7	50	0	0	0	0	0	0
16-Sep-10	Crystal Bay	24.3	3	52	27	23	23	11	12
16-Sep-10	Crystal Bay	20.2	10	71	40	31	79	45	34
16-Sep-10	Crystal Bay	20.0	20	71	37	34	74	33	41
16-Sep-10	Crystal Bay	19.9	30	67	35	32	73	38	35
16-Sep-10	Crystal Bay	19.6	40	1	0	1	6	3	3
16-Sep-10	Crystal Bay	19.7	50	7	2	5	1	1	0
10-Feb-10	Homewood	20.8	3	0	0	0	0	0	0
10-Feb-10	Homewood	20.7	10	2	1	0	1	0	1
10-Feb-10	Homewood	20.6	20	4	1	3	4	0	4
10-Feb-10	Homewood	20.6	30	3	1	2	8	3	5
10-Feb-10	Homewood	20.5	40	2	1	1	1	0	1

10-Feb-10	Homewood	20.4	50	0	0	0	2	1	1
2-Feb-10	Incline Village	23.9	3	0	0	0	0	0	0
2-Feb-10	Incline Village	23.8	10	1	0	1	0	0	0
2-Feb-10	Incline Village	23.8	20	1	0	0	0	0	0
2-Feb-10	Incline Village	23.7	30	0	0	0	2	1	1
2-Feb-10	Incline Village	23.5	40	3	0	3	0	0	0
2-Feb-10	Incline Village	23.4	50	Out of position	NA	NA	Out of position	NA	NA
9-Feb-10	King's Beach	23.2	3	10	5	5	7	4	3
9-Feb-10	King's Beach	23.1	10	4	4	0	8	5	3
9-Feb-10	King's Beach	23.0	20	17	6	11	opened	NA	NA
9-Feb-10	King's Beach	22.9	30	1	0	1	2	1	1
9-Feb-10	King's Beach	22.8	40	5	1	4	2	0	2
9-Feb-10	King's Beach	22.7	50	6	2	4	9	2	7
3-Jun-10	King's Beach	24.3	3	0	0	0	0	0	0
3-Jun-10	King's Beach	24.3	10	23	11	12	11	6	5
3-Jun-10	King's Beach	24.3	20	9	3	6	13	7	6
3-Jun-10	King's Beach	24.3	30	34	5	29	26	9	17
3-Jun-10	King's Beach	24.4	40	5	0	5	10	5	5
3-Jun-10	King's Beach	24.4	50	2	2	0	1	0	1
30-Jun-10	King's Beach	24.6	3	40	16	24	1	0	1
30-Jun-10	King's Beach	24.4	10	27	15	12	30	14	16
30-Jun-10	King's Beach	24.3	20	27	11	16	54	33	21
30-Jun-10	King's Beach	24.0	30	37	19	18	0	0	0
30-Jun-10	King's Beach	24.0	40	45	23	22	44	23	21
30-Jun-10	King's Beach	23.8	50	13	1	12	12	7	5
4-Aug-10	King's Beach	23.8	3	109	62	47	113	58	55
4-Aug-10	King's Beach	23.7	10	6	1	5	38	19	19
4-Aug-10	King's Beach	23.5	20	91	35	56	59	30	29
4-Aug-10	King's Beach	23.4	30	61	28	33	20	7	13
4-Aug-10	King's Beach	23.2	40	74	40	34	14	11	3
4-Aug-10	King's Beach	23.1	50	49	36	13	14	10	4
16-Sep-10	King's Beach	21.0	3	40	27	13	109	62	47
16-Sep-10	King's Beach	20.8	10	36	18	18	60	25	35
16-Sep-10	King's Beach	20.5	20	133	73	60	105	58	47
16-Sep-10	King's Beach	20.3	30	77	39	38	91	40	51
16-Sep-10	King's Beach	20.1	40	68	38	20	58	24	34
16-Sep-10	King's Beach	19.9	50	41	17	24	48	17	31
27-Jan-10	Marla Bay	22.0	3	0	0	0	0	0	0
27-Jan-10	Marla Bay	21.9	10	2	0	2	0	0	0
27-Jan-10	Marla Bay	21.9	20	0	0	0	0	0	0
27-Jan-10	Marla Bay	21.8	30	2	0	2	1	1	0
27-Jan-10	Marla Bay	21.8	40	1	0	1	0	0	0
27-Jan-10	Marla Bay	21.7	50	1	0	1	3	2	1
1-Jul-10	Sand Harbor	21.1	3	1	0	1	0	0	0
1-Jul-10	Sand Harbor	21.3	10	7	1	6	16	8	8
1-Jul-10	Sand Harbor	21.4	20	3	2	1	0	0	0
1-Jul-10	Sand Harbor	21.4	30	3	2	1	3	2	1
1-Jul-10	Sand Harbor	21.5	40	0	0	0	0	0	0
1-Jul-10	Sand Harbor	21.5	50	1	0	1	0	0	0
5-Aug-10	Sand Harbor	23.3	3	NA	NA	NA	NA	NA	NA
5-Aug-10	Sand Harbor	23.3	10	70	40	30	60	35	25
5-Aug-10	Sand Harbor	23.1	20	71	36	35	66	33	33
5-Aug-10	Sand Harbor	23.0	30	43	15	28	16	10	6
5-Aug-10	Sand Harbor	NA	40	NA	NA	NA	NA	NA	NA
5-Aug-10	Sand Harbor	22.6	50	9	3	6	10	4	6
15-Sep-10	Sand Harbor	27.7	3	12	7	5	15	3	12
15-Sep-10	Sand Harbor	27.3	10	45	25	20	15	5	10
15-Sep-10	Sand Harbor	27.1	20	78	42	36	88	38	50
15-Sep-10	Sand Harbor	27.0	30	39	23	16	24	15	9
15-Sep-10	Sand Harbor	26.8	40	Moved	NA	NA	NA	NA	NA

15-Sep-10	Sand Harbor	NA	50	Moved	NA	NA	NA	NA	NA
2-Feb-10	Sand Harbour	23.0	3	3	2	1	2	0	2
2-Feb-10	Sand Harbour	22.8	10	1	1	0	5	2	3
2-Feb-10	Sand Harbour	22.6	20	6	3	3	7	4	3
2-Feb-10	Sand Harbour	22.5	30	6	1	5	0	0	0
2-Feb-10	Sand Harbour	22.4	40	4	2	2	5	1	4
2-Feb-10	Sand Harbour	22.4	50	9	1	8	4	1	3
2-Feb-10	Secret Harbour	21.8	3	1	1	0	0	0	0
2-Feb-10	Secret Harbour	21.8	10	1	1	0	0	0	0
2-Feb-10	Secret Harbour	21.7	20	2	1	1	0	0	0
2-Feb-10	Secret Harbour	21.6	30	1	1	0	1	1	0
2-Feb-10	Secret Harbour	21.6	40	0	0	0	2	0	2
2-Feb-10	Secret Harbour	21.5	50	3	2	1	2	0	2
10-Feb-10	Sugar Pine Point	20.2	3	4	2	2	1	0	1
10-Feb-10	Sugar Pine Point	20.1	10	0	0	0	1	0	1
10-Feb-10	Sugar Pine Point	20.0	20	0	0	0	5	0	5
10-Feb-10	Sugar Pine Point	16.9	30	8	3	5	3	0	3
10-Feb-10	Sugar Pine Point	19.9	40	10	1	9	10	1	9
10-Feb-10	Sugar Pine Point	19.7	50	3	1	2	10	4	6
1-Jul-10	Sugar Pine Point	20.2	3	14	2	12	2	1	1
1-Jul-10	Sugar Pine Point	20.1	10	13	3	10	9	3	6
1-Jul-10	Sugar Pine Point	20.0	20	19	9	10	3	2	1
1-Jul-10	Sugar Pine Point	19.9	30	2	0	2	3	2	1
1-Jul-10	Sugar Pine Point	19.8	40	3	2	1	4	1	3
1-Jul-10	Sugar Pine Point	19.7	50	5	3	2	1	1	0
5-Aug-10	Sugar Pine Point	20.2	3	37	25	12	28	13	15
5-Aug-10	Sugar Pine Point	NA	10	NA	NA	NA	NA	NA	NA
5-Aug-10	Sugar Pine Point	20.3	20	NA	NA	NA	0	0	0
5-Aug-10	Sugar Pine Point	20.3	30	7	3	4	55	26	29
5-Aug-10	Sugar Pine Point	20.3	40	17	16	1	20	10	10
5-Aug-10	Sugar Pine Point	NA	50	NA	NA	NA	NA	NA	NA
15-Sep-10	Sugar Pine Point	22.3	3	19	5	14	24	10	24
15-Sep-10	Sugar Pine Point	22.1	10	NA	NA	NA	NA	NA	NA
15-Sep-10	Sugar Pine Point	21.9	20	70	32	38	52	22	30
15-Sep-10	Sugar Pine Point	22.7	30	NA	NA	NA	NA	NA	NA
15-Sep-10	Sugar Pine Point	21.8	40	2	2	0	7	7	0
15-Sep-10	Sugar Pine Point	21.7	50	5	2	3	6	5	1
10-Feb-10	Sunnyside	21.4	3	0	0	0	0	0	0
10-Feb-10	Sunnyside	21.4	10	4	1	3	8	3	5
10-Feb-10	Sunnyside	21.3	20	5	1	4	4	2	2
10-Feb-10	Sunnyside	21.3	30	4	0	4	2	0	2
10-Feb-10	Sunnyside	21.2	40	1	1	0	1	1	0
10-Feb-10	Sunnyside	21.2	50	3	1	2	9	4	5

3-Jun-10	Sunnyside	25.1	3	1	0	1	5	2	3
3-Jun-10	Sunnyside	25.1	10	1	1	0	2	1	1
3-Jun-10	Sunnyside	25.0	20	6	2	4	2	1	1
3-Jun-10	Sunnyside	24.9	30	2	1	1	4	0	4
3-Jun-10	Sunnyside	24.8	40	7	2	5	5	2	3
3-Jun-10	Sunnyside	24.6	50	7	5	2	4	3	1
30-Jun-10	Sunnyside	21.9	3	21	10	11	2	0	2
30-Jun-10	Sunnyside	21.8	10	3	1	2	6	1	5
30-Jun-10	Sunnyside	21.7	20	11	8	3	2	0	2
30-Jun-10	Sunnyside	21.6	30	3	1	2	7	3	4
30-Jun-10	Sunnyside	21.5	40	5	2	3	7	5	2
30-Jun-10	Sunnyside	21.3	50	8	6	2	10	8	2
4-Aug-10	Sunnyside	21.0	3	38	21	17	41	28	13
4-Aug-10	Sunnyside	NA	10	NA	NA	NA	NA	NA	NA
4-Aug-10	Sunnyside	20.9	20	22	11	11	41	22	19
4-Aug-10	Sunnyside	20.8	30	17	10	7	12	6	6
4-Aug-10	Sunnyside	20.8	40	13	9	4	4	3	1
4-Aug-10	Sunnyside	20.6	50	27	17	10	20	10	10
16-Sep-10	Sunnyside	22.4	3	38	33	5	25	19	6
16-Sep-10	Sunnyside	22.2	10	58	24	34	51	29	22
16-Sep-10	Sunnyside	22.0	20	49	35	14	9	4	5
16-Sep-10	Sunnyside	22.1	30	27	17	10	37	19	18
16-Sep-10	Sunnyside	22.0	40	13	6	7	24	16	8
16-Sep-10	Sunnyside	21.8	50	39	25	14	2	2	0
10-Feb-10	Tahoe City	22.2	3	0	0	0	0	0	0
10-Feb-10	Tahoe City	22.1	10	0	0	0	0	0	0
10-Feb-10	Tahoe City	22.0	20	21	6	15	30	20	10
10-Feb-10	Tahoe City	21.9	30	17	6	11	15	4	11
10-Feb-10	Tahoe City	21.8	40	13	5	8	16	3	13
10-Feb-10	Tahoe City	21.7	50	27	12	15	17	8	9
3-Jun-10	Tahoe City	24.5	3	6	3	3	9	4	5
3-Jun-10	Tahoe City	NA	10	NA	NA	NA	NA	NA	NA
3-Jun-10	Tahoe City	24.7	20	7	2	5	0	0	0
3-Jun-10	Tahoe City	24.7	30	5	0	5	0	0	0
3-Jun-10	Tahoe City	24.7	40	20	10	10	22	7	15
3-Jun-10	Tahoe City	24.8	50	5	2	3	5	3	2
30-Jun-10	Tahoe City	23.1	3	52	28	24	33	18	15
30-Jun-10	Tahoe City	22.8	10	63	34	29	51	27	24
30-Jun-10	Tahoe City	22.6	20	25	12	13	13	10	3
30-Jun-10	Tahoe City	22.5	30	39	19	20	19	9	10
30-Jun-10	Tahoe City	22.3	40	14	3	11	20	13	7
30-Jun-10	Tahoe City	22.2	50	22	12	10	6	2	4
4-Aug-10	Tahoe City	22.2	3	30	16	14	58	27	31
4-Aug-10	Tahoe City	22.1	10	96	47	49	88	53	35
4-Aug-10	Tahoe City	21.8	20	38	22	16	0	0	0
4-Aug-10	Tahoe City	21.7	30	44	22	22	41	26	15
4-Aug-10	Tahoe City	21.5	40	77	51	26	71	45	26
4-Aug-10	Tahoe City	21.4	50	22	15	7	0	0	0
16-Sep-10	Tahoe City	21.5	3	56	32	24	56	24	32
16-Sep-10	Tahoe City	21.3	10	102	66	36	156	68	88
16-Sep-10	Tahoe City	21.1	20	73	35	38	64	30	34
16-Sep-10	Tahoe City	20.9	30	78	47	31	76	45	31
16-Sep-10	Tahoe City	20.7	40	58	37	21	55	27	28
16-Sep-10	Tahoe City	20.6	50	33	21	12	0	0	0
27-Jan-10	Tahoe Keys	22.6	3	0	0	0	0	0	0
27-Jan-10	Tahoe Keys	22.6	10	0	0	0	0	0	0
27-Jan-10	Tahoe Keys	22.5	20	0	0	0	0	0	0
27-Jan-10	Tahoe Keys	22.5	30	0	0	0	0	0	0
27-Jan-10	Tahoe Keys	22.6	40	0	0	0	0	0	0
27-Jan-10	Tahoe Keys	22.6	50	0	0	0	0	0	0
27-Jan-10	Zephyr Cove	23.1	3	3	2	1	2	0	2
27-Jan-10	Zephyr Cove	22.9	10	0	0	0	1	1	0
27-Jan-10	Zephyr Cove	22.8	20	2	1	1	0	0	0
27-Jan-10	Zephyr Cove	22.8	30	4	1	3	3	1	2

27-Jan-10	Zephyr Cove	22.7	40	3	0	3	9	3	6
27-Jan-10	Zephyr Cove	22.6	50	3	2	4	2	1	1
25-May-11	Cave Rock	22.4	3	5	3	2	5	2	3
25-May-11	Cave Rock	NA	10	NA	NA	NA	NA	NA	NA
25-May-11	Cave Rock	NA	20	NA	NA	NA	NA	NA	NA
25-May-11	Cave Rock	22.1	30	3	0	3	0	0	0
25-May-11	Cave Rock	22.0	40	0	0	0	0	0	0
25-May-11	Cave Rock	22.0	50	1	1	0	0	0	0
7-Jun-11	Cave Rock	24.5	3	0	0	0	5	4	1
7-Jun-11	Cave Rock	24.4	10	44	21	23	43	21	22
7-Jun-11	Cave Rock	24.3	20	8	5	3	13	8	5
7-Jun-11	Cave Rock	24.3	30	4	2	2	2	1	1
7-Jun-11	Cave Rock	24.2	40	3	2	1	1	1	0
7-Jun-11	Cave Rock	24.1	50	2	0	2	0	0	0
27-Jul-11	Cave Rock	17.5	3	8	2	6	1	0	1
27-Jul-11	Cave Rock	17.6	10	62	28	34	55	18	37
27-Jul-11	Cave Rock	17.7	20	39	17	22	10	4	6
27-Jul-11	Cave Rock	17.8	30	8	2	6	7	7	0
27-Jul-11	Cave Rock	17.9	40	2	1	1	3	1	2
27-Jul-11	Cave Rock	17.9	50	2	1	1	3	2	1
31-Aug-11	Cave Rock	18.3	3	54	23	31	5	3	2
31-Aug-11	Cave Rock	18.6	10	28	18	10	41	21	20
31-Aug-11	Cave Rock	18.1	20	18	10	8	30	13	17
31-Aug-11	Cave Rock	18.0	30	19	11	8	15	11	4
31-Aug-11	Cave Rock	17.9	40	2	2	0	0	0	0
31-Aug-11	Cave Rock	17.8	50	1	0	1	2	1	1
22-Oct-11	Cave Rock	21.6	3	1	0	1	9	2	7
22-Oct-11	Cave Rock	21.5	10	33	26	6	42	33	9
22-Oct-11	Cave Rock	21.4	20	44	23	21	41	20	21
22-Oct-11	Cave Rock	21.1	30	20	10	10	21	13	8
22-Oct-11	Cave Rock	21.0	40	10	3	7	16	8	8
22-Oct-11	Cave Rock	20.9	50	4	2	2	5	2	3
22-May-11	Crystal Bay	22.3	3	8	2	6	3	1	2
22-May-11	Crystal Bay	22.1	10	20	5	15	51	15	36
22-May-11	Crystal Bay	22.0	20	22	6	14	36	8	28
22-May-11	Crystal Bay	21.9	30	11	2	9	19	11	8
22-May-11	Crystal Bay	21.8	40	2	1	1	0	0	0
22-May-11	Crystal Bay	NA	50	0	0	0	0	0	0
6-Jun-11	Crystal Bay	20.1	3	6	1	5	9	3	6
6-Jun-11	Crystal Bay	20.1	10	33	16	17	40	20	20
6-Jun-11	Crystal Bay	20.0	20	33	15	18	24	11	13
6-Jun-11	Crystal Bay	19.9	30	16	8	8	4	1	3
6-Jun-11	Crystal Bay	19.8	40	5	2	3	0	0	0
6-Jun-11	Crystal Bay	NA	50	NA	NA	NA	NA	NA	NA
28-Jul-11	Crystal Bay	24.2	3	7	2	5	4	2	2
28-Jul-11	Crystal Bay	24.0	10	65	29	36	72	29	43
28-Jul-11	Crystal Bay	23.9	20	75	40	35	57	30	27
28-Jul-11	Crystal Bay	23.7	30	30	9	21	3	1	2
28-Jul-11	Crystal Bay	23.5	40	4	2	2	2	0	2
28-Jul-11	Crystal Bay	23.4	50	11	5	6	0	0	0
1-Sep-11	Crystal Bay	NA	3	NA	NA	NA	NA	NA	NA
1-Sep-11	Crystal Bay	25.8	10	45	22	23	51	20	31
1-Sep-11	Crystal Bay	25.7	20	57	31	26	59	26	33
1-Sep-11	Crystal Bay	25.6	30	53	23	30	55	30	25
1-Sep-11	Crystal Bay	25.4	40	13	5	8	36	21	15
1-Sep-11	Crystal Bay	25.3	50	3	2	1	8	5	3
21-Oct-11	Crystal Bay	22.7	3	2	1	1	2	0	2
21-Oct-11	Crystal Bay	22.6	10	102	55	47	20	9	11
21-Oct-11	Crystal Bay	22.4	20	21	19	2	59	34	25
21-Oct-11	Crystal Bay	22.3	30	34	20	14	66	40	26
21-Oct-11	Crystal Bay	NA	40	NA	NA	NA	NA	NA	NA
21-Oct-11	Crystal Bay	22.1	50	32	19	13	17	10	7
25-May-11	Emerald Bay	23.3	3	4	0	4	1	0	1
25-May-11	Emerald Bay	23.3	10	4	1	3	4	2	2

25-May-11	Emerald Bay	23.3	20	5	1	4	7	1	6
25-May-11	Emerald Bay	23.2	30	1	1	0	2	0	2
25-May-11	Emerald Bay	23.3	40	0	0	0	0	0	0
25-May-11	Emerald Bay	23.3	50	0	0	0	0	0	0
7-Jun-11	Emerald Bay	24.3	3	2	1	1	14	2	12
7-Jun-11	Emerald Bay	24.2	10	3	1	2	2	0	2
7-Jun-11	Emerald Bay	24.2	20	2	0	2	3	2	1
7-Jun-11	Emerald Bay	24.1	30	0	0	0	0	0	0
7-Jun-11	Emerald Bay	24.1	40	1	1	0	0	0	0
7-Jun-11	Emerald Bay	24.0	50	0	0	0	0	0	0
27-Jul-11	Emerald Bay	15.5	3	42	16	26	12	8	4
27-Jul-11	Emerald Bay	NA	10	NA	NA	NA	NA	NA	NA
27-Jul-11	Emerald Bay	15.4	20	10	5	5	7	5	2
27-Jul-11	Emerald Bay	15.3	30	5	2	3	1	1	0
27-Jul-11	Emerald Bay	15.2	40	1	0	1	2	0	2
27-Jul-11	Emerald Bay	15.1	50	0	0	0	0	0	0
31-Aug-11	Emerald Bay	15.6	3	45	28	17	20	7	13
31-Aug-11	Emerald Bay	15.5	10	1	1	0	6	2	4
31-Aug-11	Emerald Bay	15.5	20	6	2	4	7	3	4
31-Aug-11	Emerald Bay	15.4	30	3	3	0	5	3	2
31-Aug-11	Emerald Bay	15.3	40	0	0	0	0	0	0
31-Aug-11	Emerald Bay	15.3	50	0	0	0	0	0	0
22-Oct-11	Emerald Bay	22.0	3	15	1	14	10	2	8
22-Oct-11	Emerald Bay	21.9	10	4	1	3	1	0	1
22-Oct-11	Emerald Bay	21.8	20	8	1	7	10	2	8
22-Oct-11	Emerald Bay	21.7	30	2	1	1	11	1	10
22-Oct-11	Emerald Bay	21.6	40	1	1	0	2	2	0
22-Oct-11	Emerald Bay	21.5	50	0	0	0	2	1	1
27-Jul-11	Lakeside	18.9	3	0	0	0	0	0	0
27-Jul-11	Lakeside	18.8	10	1	1	0	0	0	0
27-Jul-11	Lakeside	18.7	20	0	0	0	1	1	0
27-Jul-11	Lakeside	18.7	30	0	0	0	0	0	0
27-Jul-11	Lakeside	18.6	40	0	0	0	0	0	0
27-Jul-11	Lakeside	18.5	50	0	0	0	0	0	0
25-May-11	Marla Bay	NA	3	Moved	NA	NA	NA	NA	NA
25-May-11	Marla Bay	NA	10	Moved	NA	NA	NA	NA	NA
25-May-11	Marla Bay	NA	20	Moved	NA	NA	NA	NA	NA
25-May-11	Marla Bay	NA	30	Moved	NA	NA	NA	NA	NA
25-May-11	Marla Bay	NA	40	Moved	NA	NA	NA	NA	NA
25-May-11	Marla Bay	NA	50	Moved	NA	NA	NA	NA	NA
4-Jun-11	Marla Bay	16.6	3	0	0	0	0	0	0
4-Jun-11	Marla Bay	16.5	10	0	0	0	0	0	0
4-Jun-11	Marla Bay	16.5	20	0	0	0	0	0	0
4-Jun-11	Marla Bay	16.4	30	0	0	0	0	0	0
4-Jun-11	Marla Bay	16.3	40	0	0	0	0	0	0
4-Jun-11	Marla Bay	16.3	50	0	0	0	0	0	0
7-Jun-11	Marla Bay	24.4	3	1	0	1	1	0	1
7-Jun-11	Marla Bay	24.2	10	0	0	0	0	0	0
7-Jun-11	Marla Bay	NA	20	NA	NA	NA	NA	NA	NA
7-Jun-11	Marla Bay	24.0	30	0	0	0	1	1	0
7-Jun-11	Marla Bay	24.0	40	0	0	0	0	0	0
7-Jun-11	Marla Bay	NA	50	NA	NA	NA	NA	NA	NA
31-Aug-11	Marla Bay	19.7	3	4	2	2	3	1	2
31-Aug-11	Marla Bay	19.5	10	37	8	29	23	12	11
31-Aug-11	Marla Bay	19.3	20	20	13	7	16	12	4
31-Aug-11	Marla Bay	19.3	30	0	0	0	0	0	0
31-Aug-11	Marla Bay	19.2	40	0	0	0	0	0	0
31-Aug-11	Marla Bay	19.1	50	0	0	0	0	0	0
22-May-11	Sand Harbor	22.5	3	0	0	3	0	0	0

22-May-11	Sand Harbor	22.4	10	4	1	3	5	0	5
22-May-11	Sand Harbor	22.3	20	2	1	1	3	0	3
22-May-11	Sand Harbor	22.0	30	1	0	1	4	0	4
22-May-11	Sand Harbor	21.9	40	2	1	1	2	2	0
22-May-11	Sand Harbor	21.8	50	8	4	4	0	0	0
6-Jun-11	Sand harbor	17.9	3	0	0	0	2	0	2
6-Jun-11	Sand harbor	17.9	10	25	13	12	0	0	0
6-Jun-11	Sand harbor	17.7	20	31	9	22	15	8	7
6-Jun-11	Sand harbor	17.7	30	18	10	8	9	3	6
6-Jun-11	Sand harbor	17.6	40	5	1	4	2	0	2
6-Jun-11	Sand harbor	17.5	50	0	0	0	0	0	0
28-Jul-11	Sand Harbor	22.7	3	1	1	0	0	0	0
28-Jul-11	Sand Harbor	15.7	10	~	NA	NA	22	12	10
28-Jul-11	Sand Harbor	22.7	20	43	16	27	11	4	7
28-Jul-11	Sand Harbor	22.7	30	17	12	5	8	5	3
28-Jul-11	Sand Harbor	22.6	40	7	5	2	16	5	11
28-Jul-11	Sand Harbor	15.5	50	6	3	3	19	11	8
1-Sep-11	Sand Harbor	25.8	3	9	4	5	8	3	5
1-Sep-11	Sand Harbor	25.5	10	12	3	9	7	4	3
1-Sep-11	Sand Harbor	25.4	20	33	17	16	48	16	32
1-Sep-11	Sand Harbor	25.3	30	54	19	35	39	11	28
1-Sep-11	Sand Harbor	25.1	40	13	5	8	12	5	7
1-Sep-11	Sand Harbor	25.0	50	8	4	4	0	0	0
25-May-11	Sugar Pine Point	23.4	3	3	3	0	1	0	1
25-May-11	Sugar Pine Point	23.3	10	0	0	0	1	0	1
25-May-11	Sugar Pine Point	NA	20	Moved	NA	NA	NA	NA	NA
25-May-11	Sugar Pine Point	23.2	30	6	2	4	6	2	4
25-May-11	Sugar Pine Point	23.1	40	2	1	1	4	2	2
25-May-11	Sugar Pine Point	NA	50	Moved	NA	NA	NA	NA	NA
7-Jun-11	Sugar Pine Point	24.3	3	3	2	1	3	0	3
7-Jun-11	Sugar Pine Point	24.2	10	21	12	9	3	1	2
7-Jun-11	Sugar Pine Point	24.1	20	2	0	2	4	1	3
7-Jun-11	Sugar Pine Point	24.0	30	Rope Broke lost traps	NA	NA	NA	NA	NA
7-Jun-11	Sugar Pine Point	23.9	40	2	2	0	1	0	1
7-Jun-11	Sugar Pine Point	23.8	50	1	1	0	1	0	1
27-Jul-11	Sugar Pine Point	18.1	3	17	8	9	19	12	7
27-Jul-11	Sugar Pine Point	NA	10	~	NA	NA	NA	NA	NA
27-Jul-11	Sugar Pine Point	18.1	20	9	8	1	10	6	4
27-Jul-11	Sugar Pine Point	18.1	30	6	3	3	3	3	0
27-Jul-11	Sugar Pine Point	18.0	40	6	4	2	5	4	1
27-Jul-11	Sugar Pine Point	18.1	50	1	1	0	2	1	1
31-Aug-11	Sugar Pine Point	15.3	3	30	NA	NA	14	9	5
31-Aug-11	Sugar Pine Point	NA	10	~	NA	NA	~	NA	NA
31-Aug-11	Sugar Pine Point	15.2	20	~	NA	NA	9	2	7
31-Aug-11	Sugar Pine	14.9	30	16	10	6	0	0	0

	Point								
31-Aug-11	Sugar Pine Point	14.8	40	8	4	4	7	4	3
31-Aug-11	Sugar Pine Point	14.7	50	1	1	0	0	0	0
22-Oct-11	Sugar Pine Point	21.2	3	2	0	2	8	3	5
22-Oct-11	Sugar Pine Point	21.0	10	35	28	7	43	25	18
22-Oct-11	Sugar Pine Point	20.9	20	51	29	22	31	12	19
22-Oct-11	Sugar Pine Point	20.7	30	26	16	10	36	23	13
22-Oct-11	Sugar Pine Point	20.5	40	9	5	4	2	1	1
22-Oct-11	Sugar Pine Point	20.3	50	0	0	0	1	1	0
22-May-11	Sunnyside	22.3	3	1	0	1	0	0	0
22-May-11	Sunnyside	22.2	10	2	1	1	2	1	1
22-May-11	Sunnyside	22.1	20	0	0	0	0	0	0
22-May-11	Sunnyside	22.1	30	1	1	0	1	1	0
22-May-11	Sunnyside	21.9	40	2	2	0	3	1	2
22-May-11	Sunnyside	21.8	50	4	1	3	0	0	0
6-Jun-11	Sunnyside	20.2	3	15	7	8	2	1	1
6-Jun-11	Sunnyside	20.2	10	25	12	13	12	6	6
6-Jun-11	Sunnyside	20.2	20	11	3	8	3	2	1
6-Jun-11	Sunnyside	20.3	30	5	2	3	2	0	2
6-Jun-11	Sunnyside	20.3	40	3	2	1	1	1	0
6-Jun-11	Sunnyside	20.3	50	2	2	0	5	2	3
28-Jul-11	Sunnyside	25.9	3	24	11	13	33	19	14
28-Jul-11	Sunnyside	16.0	10	41	22	19	38	19	19
28-Jul-11	Sunnyside	25.8	20	13	12	1	10	7	3
28-Jul-11	Sunnyside	25.7	30	8	5	3	15	10	5
28-Jul-11	Sunnyside	25.7	40	2	1	1	7	7	0
28-Jul-11	Sunnyside	25.6	50	0	0	0	2	1	1
1-Sep-11	Sunnyside	26.4	3	2	1	1	21	8	13
1-Sep-11	Sunnyside	26.3	10	19	14	5	24	15	9
1-Sep-11	Sunnyside	26.2	20	32	23	9	34	22	12
1-Sep-11	Sunnyside	26.2	30	7	5	2	Moved	NA	NA
1-Sep-11	Sunnyside	26.1	40	21	15	6	19	12	7
1-Sep-11	Sunnyside	26.0	50	8	5	3	6	5	1
21-Oct-11	Sunnyside	25.4	3	1	0	1	1	0	1
21-Oct-11	Sunnyside	25.3	10	7	5	2	1	1	0
21-Oct-11	Sunnyside	25.2	20	12	6	6	9	4	5
21-Oct-11	Sunnyside	25.1	30	18	13	5	17	11	6
21-Oct-11	Sunnyside	25.0	40	43	25	18	38	24	14
21-Oct-11	Sunnyside	24.9	50	18	11	7	11	8	3
22-May-11	Tahoe City	22.6	3	9	5	4	8	3	5
22-May-11	Tahoe City	22.4	10	16	7	9	0	0	0
22-May-11	Tahoe City	22.2	20	23	7	16	9	2	7
22-May-11	Tahoe City	22.1	30	13	7	6	15	3	12
22-May-11	Tahoe City	21.9	40	7	0	7	13	7	6
22-May-11	Tahoe City	21.7	50	13	5	8	6	3	3
6-Jun-11	Tahoe City	20.0	3	22	14	8	5	2	3
6-Jun-11	Tahoe City	NA	10	NA	NA	NA	NA	NA	NA
6-Jun-11	Tahoe City	20.1	20	46	14	32	17	11	6
6-Jun-11	Tahoe City	20.1	30	51	23	28	42	18	24
6-Jun-11	Tahoe City	20.2	40	27	13	14	25	12	13
6-Jun-11	Tahoe City	20.2	50	16	6	10	10	7	3
28-Jul-11	Tahoe City	25.2	3	40	18	22	33	18	15
28-Jul-11	Tahoe City	15.8	10	70	42	28	70	26	44
28-Jul-11	Tahoe City	15.8	20	65	32	33	67	30	37
28-Jul-11	Tahoe City	15.9	30	65	31	34	45	23	22
28-Jul-11	Tahoe City	15.9	40	27	8	19	25	13	12
28-Jul-11	Tahoe City	15.9	50	22	12	10	3	1	2

1-Sep-11	Tahoe City	26.6	3	39	27	12	41	24	17
1-Sep-11	Tahoe City	26.5	10	0	0	0	0	0	0
1-Sep-11	Tahoe City	26.4	20	41	18	23	29	20	9
1-Sep-11	Tahoe City	26.3	30	44	27	17	50	31	19
1-Sep-11	Tahoe City	26.1	40	36	8	28	40	31	9
1-Sep-11	Tahoe City	25.9	50	19	14	5	44	36	8
21-Oct-11	Tahoe City	24.6	3	33	20	13	15	3	12
21-Oct-11	Tahoe City	24.5	10	~	NA	NA	15	8	7
21-Oct-11	Tahoe City	24.2	20	103	59	44	50	31	19
21-Oct-11	Tahoe City	23.9	30	66	43	23	77	45	32
21-Oct-11	Tahoe City	23.8	40	64	46	18	67	45	22
21-Oct-11	Tahoe City	23.6	50	50	34	16	38	30	8
6-Jan-12	Cave Rock	22.8	3	0	0	0	0	2	1
6-Jan-12	Cave Rock	22.7	10	1	0	1	0	1	0
6-Jan-12	Cave Rock	22.6	20	4	0	4	0	0	0
6-Jan-12	Cave Rock	22.5	30	16	0	16	0	11	0
6-Jan-12	Cave Rock	22.5	40	6	1	5	0	1	1
6-Jan-12	Cave Rock	22.4	50	5	0	5	0	0	0
23-Apr-12	Cave Rock	23.7	3	0	0	0	3	0	0
23-Apr-12	Cave Rock	23.6	10	8	2	6	0	3	1
23-Apr-12	Cave Rock	23.5	20	0	0	0	0	1	0
23-Apr-12	Cave Rock	23.4	30	1	0	1	0	2	0
23-Apr-12	Cave Rock	23.4	40	1	0	1	0	1	0
23-Apr-12	Cave Rock	23.3	50	0	0	0	0	0	0
31-May-12	Cave Rock	17.3	3	0	0	0	11	1	0
31-May-12	Cave Rock	17.3	10	2	0	2	21	2	0
31-May-12	Cave Rock	17.4	20	11	3	8	0	5	1
31-May-12	Cave Rock	17.5	30	1	0	1	0	2	2
31-May-12	Cave Rock	17.6	40	1	0	1	0	0	0
31-May-12	Cave Rock	17.6	50	1	0	1	0	7	0
27-Jun-12	Cave Rock	25.5	3	2	2	0	3	2	1
27-Jun-12	Cave Rock	25.5	10	24	15	9	0	13	10
27-Jun-12	Cave Rock	25.4	20	23	13	10	0	47	27
27-Jun-12	Cave Rock	25.2	30	32	16	16	0	46	25
27-Jun-12	Cave Rock	25.1	40	12	9	3	0	7	4
27-Jun-12	Cave Rock	25.1	50	4	2	2	0	14	8
24-Jul-12	Cave Rock	25.8	3	27	14	13	0	9	7
24-Jul-12	Cave Rock	25.6	10	47	24	23	0	54	29
24-Jul-12	Cave Rock	25.5	20	91	44	47	0	78	37
24-Jul-12	Cave Rock	25.4	30	64	25	39	0	57	21
24-Jul-12	Cave Rock	25.2	40	27	11	16	0	71	32
24-Jul-12	Cave Rock	24.9	50	34	19	15	0	20	10
23-Aug-12	Cave Rock	19.1	3	43	17	26	NA	27	14
23-Aug-12	Cave Rock	19.0	10	5	3	2	NA	83	35
23-Aug-12	Cave Rock	18.9	20	50	20	30	NA	17	12
23-Aug-12	Cave Rock	18.8	30	37	27	10	NA	30	14
23-Aug-12	Cave Rock	18.7	40	36	22	14	NA	37	19
23-Aug-12	Cave Rock	18.6	50	18	7	11	NA	26	16
10-Oct-12	Cave Rock	17.6	3	44	31	13	0	NA	NA
10-Oct-12	Cave Rock	17.5	10	38	12	26	0	67	39
10-Oct-12	Cave Rock	17.4	20	71	39	32	0	45	25
10-Oct-12	Cave Rock	17.4	30	37	17	20	0	33	17
10-Oct-12	Cave Rock	17.3	40	33	15	18	0	33	20
10-Oct-12	Cave Rock	17.1	50	23	19	4	0	0	0
31-Oct-12	Cave Rock	19.4	3	0	0	0	0	3	0
31-Oct-12	Cave Rock	19.3	10	1	0	1	0	0	0
31-Oct-12	Cave Rock	19.2	20	15	7	8	0	17	6
31-Oct-12	Cave Rock	19.1	30	8	3	5	0	15	10
31-Oct-12	Cave Rock	19.0	40	8	6	2	0	6	4
31-Oct-12	Cave Rock	18.9	50	8	4	4	0	NA	NA
30-Dec-12	Cave Rock	18.1	3	0	0	0	0	0	0
30-Dec-12	Cave Rock	18.2	10	1	1	0	0	2	1
30-Dec-12	Cave Rock	18.2	20	0	0	0	0	3	1
30-Dec-12	Cave Rock	18.3	30	3	1	2	0	4	1

30-Dec-12	Cave Rock	18.3	40	4	1	3	0	1	0
30-Dec-12	Cave Rock	18.3	50	3	1	2	0	5	2
5-Jan-12	Crystal Bay	21.4	3	0	0	0	1	0	0
5-Jan-12	Crystal Bay	21.3	10	5	2	3	0	6	3
5-Jan-12	Crystal Bay	21.2	20	36	25	11	0	43	22
5-Jan-12	Crystal Bay	21.1	30	9	5	4	0	15	5
5-Jan-12	Crystal Bay	21.1	40	5	5	0	0	7	2
5-Jan-12	Crystal Bay	21.0	50	6	1	5	5	6	3
24-Feb-12	Crystal Bay	20.3	3	0	0	0	3	0	0
24-Feb-12	Crystal Bay	20.2	10	10	7	3	0	8	5
24-Feb-12	Crystal Bay	20.1	20	11	5	6	0	17	9
24-Feb-12	Crystal Bay	20.0	30	12	6	6	0	6	2
24-Feb-12	Crystal Bay	19.9	40	1	1	0	0	2	0
24-Feb-12	Crystal Bay	19.8	50	2	2	0	0	0	0
7-Apr-12	Crystal Bay	22.7	3	0	0	0	0	0	0
7-Apr-12	Crystal Bay	22.7	10	1	0	1	2	6	2
7-Apr-12	Crystal Bay	22.7	20	5	2	3	2	15	7
7-Apr-12	Crystal Bay	22.7	30	0	0	0	0	0	0
7-Apr-12	Crystal Bay	22.6	40	0	0	0	0	0	0
7-Apr-12	Crystal Bay	22.6	50	0	0	0	0	2	0
23-Apr-12	Crystal Bay	21.4	3	1	0	1	1	7	4
23-Apr-12	Crystal Bay	21.4	10	5	3	2	1	12	6
23-Apr-12	Crystal Bay	21.3	20	3	2	1	2	28	13
23-Apr-12	Crystal Bay	21.3	30	9	6	3	0	13	8
23-Apr-12	Crystal Bay	21.2	40	0	0	0	0	7	4
23-Apr-12	Crystal Bay	24.0	50	1	0	1	0	1	0
20-May-12	Crystal Bay	21.4	3	2	1	1	0	0	0
20-May-12	Crystal Bay	21.3	10	30	11	19	0	0	0
20-May-12	Crystal Bay	21.3	20	7	4	3	0	42	15
20-May-12	Crystal Bay	21.2	30	14	5	9	0	25	8
20-May-12	Crystal Bay	21.2	40	3	1	2	0	24	13
20-May-12	Crystal Bay	24.4	50	0	0	0	0	1	0
21-Jun-12	Crystal Bay	20.3	3	10	4	6	1	6	3
21-Jun-12	Crystal Bay	20.2	10	54	18	NA	0	11	2
21-Jun-12	Crystal Bay	20.2	20	34	17	17	0	30	15
21-Jun-12	Crystal Bay	20.2	30	34	17	17	0	40	16
21-Jun-12	Crystal Bay	20.1	40	14	3	11	0	9	3
21-Jun-12	Crystal Bay	20.0	50	5	2	3	0	2	1
26-Jul-12	Crystal Bay	20.0	3	29	11	18	0	37	12
26-Jul-12	Crystal Bay	23.0	10	NA	NA	NA	NA	2	0
26-Jul-12	Crystal Bay	20.0	20	15	10	5	0	33	16
26-Jul-12	Crystal Bay	19.9	30	64	29	35	0	60	24
26-Jul-12	Crystal Bay	19.8	40	38	23	15	0	39	19
26-Jul-12	Crystal Bay	19.8	50	13	5	8	0	13	5
30-Aug-12	Crystal Bay	19.1	3	34	13	21	11	55	31
30-Aug-12	Crystal Bay	19.0	10	53	23	30	0	4	4
30-Aug-12	Crystal Bay	18.9	20	62	29	33	0	37	12
30-Aug-12	Crystal Bay	18.8	30	45	25	20	0	81	41
30-Aug-12	Crystal Bay	18.6	40	40	25	7	0	54	24
30-Aug-12	Crystal Bay	18.6	50	13	5	8	0	21	9
13-Oct-12	Crystal Bay	23.8	3	12	7	5	11	7	6
13-Oct-12	Crystal Bay	23.8	10	19	10	9	0	43	29
13-Oct-12	Crystal Bay	23.6	20	16	6	10	0	51	28
13-Oct-12	Crystal Bay	23.5	30	63	31	32	0	30	16
13-Oct-12	Crystal Bay	23.3	40	14	7	7	0	9	4
13-Oct-12	Crystal Bay	23.2	50	11	7	4	0	6	3
7-Nov-12	Crystal Bay	23.0	3	1	1	0	0	2	2
7-Nov-12	Crystal Bay	23.0	10	5	0	5	0	3	1
7-Nov-12	Crystal Bay	22.9	20	39	22	17	0	29	17
7-Nov-12	Crystal Bay	22.8	30	36	21	15	0	73	41
7-Nov-12	Crystal Bay	22.8	40	19	10	9	0	21	6
7-Nov-12	Crystal Bay	22.6	50	5	2	3	0	11	5
5-Jan-13	Crystal Bay	22.9	3	0	0	0	2	3	1
5-Jan-13	Crystal Bay	22.7	10	0	0	0	2	11	4

5-Jan-13	Crystal Bay	22.7	20	24	7	17	0	36	17
5-Jan-13	Crystal Bay	22.7	30	20	11	9	0	12	5
5-Jan-13	Crystal Bay	22.6	40	1	0	1	0	4	4
5-Jan-13	Crystal Bay	22.6	50	0	0	0	0	2	2
6-Jan-12	Emerald Bay	21.7	3	0	0	0	1	0	0
6-Jan-12	Emerald Bay	21.6	10	3	1	2	0	7	3
6-Jan-12	Emerald Bay	21.5	20	3	0	3	0	7	1
6-Jan-12	Emerald Bay	21.4	30	11	4	7	0	6	4
6-Jan-12	Emerald Bay	21.3	40	2	1	1	0	2	0
6-Jan-12	Emerald Bay	21.3	50	0	0	0	0	0	0
23-Apr-12	Emerald Bay	24.0	3	3	0	3	0	1	1
23-Apr-12	Emerald Bay	24.0	10	1	0	1	1	2	0
23-Apr-12	Emerald Bay	23.8	20	1	0	1	0	2	0
23-Apr-12	Emerald Bay	23.8	30	4	1	3	0	4	1
23-Apr-12	Emerald Bay	23.7	40	2	1	1	0	5	1
23-Apr-12	Emerald Bay	23.7	50	1	0	1	0	2	2
31-May-12	Emerald Bay	19.4	3	3	0	3	0	6	2
31-May-12	Emerald Bay	19.4	10	9	2	7	0	15	3
31-May-12	Emerald Bay	19.3	20	7	6	1	0	17	3
31-May-12	Emerald Bay	19.2	30	5	1	4	0	4	1
31-May-12	Emerald Bay	19.1	40	2	1	1	0	2	1
31-May-12	Emerald Bay	19.1	50	2	1	1	0	1	0
27-Jun-12	Emerald Bay	27.4	3	4	2	2	1	15	9
27-Jun-12	Emerald Bay	27.3	10	6	3	3	0	28	13
27-Jun-12	Emerald Bay	17.9	20	23	11	12	0	23	13
27-Jun-12	Emerald Bay	27.3	30	3	1	2	0	10	6
27-Jun-12	Emerald Bay	27.2	40	3	2	1	0	3	1
27-Jun-12	Emerald Bay	27.0	50	3	2	1	0	1	1
24-Jul-12	Emerald Bay	25.1	3	1	0	1	0	28	13
24-Jul-12	Emerald Bay	25.0	10	10	7	3	0	37	18
24-Jul-12	Emerald Bay	24.9	20	5	2	3	0	6	4
24-Jul-12	Emerald Bay	24.8	30	12	6	6	0	8	3
24-Jul-12	Emerald Bay	24.7	40	6	3	3	0	13	4
24-Jul-12	Emerald Bay	24.5	50	0	0	0	0	2	0
23-Aug-12	Emerald Bay	22.9	3	21	9	12	0	44	24
23-Aug-12	Emerald Bay	22.9	10	31	12	19	0	46	20
23-Aug-12	Emerald Bay	22.8	20	2	0	2	0	14	2
23-Aug-12	Emerald Bay	22.8	30	15	10	5	0	8	4
23-Aug-12	Emerald Bay	22.7	40	2	0	2	0	1	1
23-Aug-12	Emerald Bay	22.7	50	0	0	0	0	0	0
10-Oct-12	Emerald Bay	18.0	3	7	2	5	0	27	15
10-Oct-12	Emerald Bay	18.0	10	26	13	13	0	28	14
10-Oct-12	Emerald Bay	17.9	20	5	2	3	0	7	4
10-Oct-12	Emerald Bay	17.8	30	4	3	1	0	3	2
10-Oct-12	Emerald Bay	17.7	40	11	4	7	0	12	6
10-Oct-12	Emerald Bay	17.6	50	1	1	0	0	0	0
31-Oct-12	Emerald Bay	20.2	3	2	0	2	0	5	0
31-Oct-12	Emerald Bay	20.1	10	20	6	20	0	16	8
31-Oct-12	Emerald Bay	20.0	20	34	12	22	0	12	6
31-Oct-12	Emerald Bay	20.0	30	1	0	1	0	0	0
31-Oct-12	Emerald Bay	19.9	40	7	0	7	0	2	0
31-Oct-12	Emerald Bay	19.8	50	2	0	2	1	0	0
30-Dec-12	Emerald Bay	20.3	3	1	0	1	0	3	0
30-Dec-12	Emerald Bay	20.1	10	20	5	15	0	8	1
30-Dec-12	Emerald Bay	20.2	20	10	3	7	0	6	1
30-Dec-12	Emerald Bay	20.1	30	7	3	4	0	11	9
30-Dec-12	Emerald Bay	20.0	40	5	4	1	0	16	4
30-Dec-12	Emerald Bay	20.0	50	2	1	0	0	2	1
13-Oct-12	King's Beach	25.2	3	NA	NA	NA	NA	77	52
13-Oct-12	King's Beach	25.1	10	52	32	20	0	NA	NA
13-Oct-12	King's Beach	25.1	20	106	54	52	0	87	45
13-Oct-12	King's Beach	24.9	30	51	33	18	0	38	21
13-Oct-12	King's Beach	24.8	40	89	50	39	0	73	41
13-Oct-12	King's Beach	24.6	50	62	39	23	0	46	27

3-Jan-13	King's Beach	23.5	3	11	5	6	0	3	0
3-Jan-13	King's Beach	23.5	10	10	6	4	0	10	7
3-Jan-13	King's Beach	23.3	30	45	7	38	0	32	7
3-Jan-13	King's Beach	23.3	40	52	14	38	0	35	4
3-Jan-13	King's Beach	23.2	50	42	12	30	0	50	4
5-Jan-13	King's Beach	22.9	20	65	25	40	0	22	11
20-May-12	Kings Beach	24.3	3	22	13	9	0	3	2
20-May-12	Kings Beach	24.2	10	4	3	1	1	11	2
20-May-12	Kings Beach	24.0	20	38	21	17	0	36	16
20-May-12	Kings Beach	23.9	30	16	10	6	0	10	2
20-May-12	Kings Beach	23.8	40	6	3	3	0	3	1
20-May-12	Kings Beach	23.7	50	0	0	0	0	1	0
20-Jun-12	Kings Beach	26.7	3	20	12	8	0	39	18
20-Jun-12	Kings Beach	26.7	10	27	11	16	0	23	14
20-Jun-12	Kings Beach	26.8	20	43	10	33	0	25	9
20-Jun-12	Kings Beach	26.8	30	35	14	21	0	53	22
20-Jun-12	Kings Beach	26.9	40	40	14	26	0	33	11
20-Jun-12	Kings Beach	27.0	50	7	3	4	0	29	7
26-Jul-12	Kings Beach	21.4	3	29	14	15	0	30	16
26-Jul-12	Kings Beach	21.2	10	35	16	19	0	22	14
26-Jul-12	Kings Beach	21.0	20	71	37	34	0	114	66
26-Jul-12	Kings Beach	20.8	30	73	35	38	0	81	45
26-Jul-12	Kings Beach	20.6	40	73	44	29	0	84	52
26-Jul-12	Kings Beach	20.4	50	45	27	18	0	47	22
30-Aug-12	Kings Beach	19.4	3	88	53	35	0	85	47
30-Aug-12	Kings Beach	19.3	10	86	48	38	0	57	37
30-Aug-12	Kings Beach	19.0	20	45	21	24	0	52	31
30-Aug-12	Kings Beach	18.7	30	57	22	35	0	75	31
30-Aug-12	Kings Beach	18.6	40	9	3	6	0	46	24
30-Aug-12	Kings Beach	18.5	50	16	11	5	0	17	8
7-Nov-12	Kings Beach	24.0	3	64	3	61	0	48	8
7-Nov-12	Kings Beach	24.0	10	13	7	6	0	16	9
7-Nov-12	Kings Beach	24.0	20	62	19	43	0	53	18
7-Nov-12	Kings Beach	24.0	30	34	7	27	0	36	27
7-Nov-12	Kings Beach	24.0	40	69	18	51	0	39	12
7-Nov-12	Kings Beach	24.0	50	38	6	32	0	41	11
27-Jun-12	Marla Bay	24.1	3	0	0	0	0	2	2
27-Jun-12	Marla Bay	24.0	10	0	0	0	11	0	0
27-Jun-12	Marla Bay	23.9	20	3	2	1	1	9	3
27-Jun-12	Marla Bay	23.8	30	2	2	0	0	1	1
27-Jun-12	Marla Bay	23.6	40	2	1	1	0	4	2
27-Jun-12	Marla Bay	23.5	50	0	0	0	0	0	0
24-Jul-12	Marla Bay	25.9	3	1	1	0	1	0	0
24-Jul-12	Marla Bay	26.1	10	NA	NA	NA	NA	20	6
24-Jul-12	Marla Bay	25.9	20	18	9	9	0	12	5
24-Jul-12	Marla Bay	25.8	30	17	5	12	0	7	3
24-Jul-12	Marla Bay	25.7	40	1	0	0	0	2	2
24-Jul-12	Marla Bay	25.5	50	0	0	0	0	0	0
23-Aug-12	Marla Bay	18.9	3	2	1	1	NA	2	2
23-Aug-12	Marla Bay	18.8	10	25	19	6	0	13	11
23-Aug-12	Marla Bay	18.7	20	50	32	18	0	6	4
23-Aug-12	Marla Bay	18.5	30	9	5	4	0	15	9
23-Aug-12	Marla Bay	18.4	40	10	5	5	0	3	1
23-Aug-12	Marla Bay	18.3	50	0	0	0	0	1	1
10-Oct-12	Marla Bay	17.3	3	1	0	1	7	5	0
10-Oct-12	Marla Bay	17.3	10	43	28	15	0	48	26
10-Oct-12	Marla Bay	17.1	20	11	9	2	0	25	20
10-Oct-12	Marla Bay	17.0	30	3	2	1	0	0	0
10-Oct-12	Marla Bay	16.9	40	5	4	1	0	3	3
10-Oct-12	Marla Bay	16.7	50	1	1	0	0	0	0
31-Oct-12	Marla Bay	19.6	3	1	1	0	2	1	0
31-Oct-12	Marla Bay	19.6	10	1	0	1	0	4	1
31-Oct-12	Marla Bay	19.5	20	0	0	0	0	2	2
31-Oct-12	Marla Bay	19.4	30	2	2	0	0	2	1

31-Oct-12	Marla Bay	19.3	40	0	0	0	0	3	0
31-Oct-12	Marla Bay	19.3	50	0	0	0	0	0	0
30-Dec-12	Marla Bay	19.3	3	0	0	0	0	0	0
30-Dec-12	Marla Bay	19.2	10	2	0	2	0	0	0
30-Dec-12	Marla Bay	19.1	20	0	0	0	0	4	1
30-Dec-12	Marla Bay	19.1	30	0	0	0	0	2	2
30-Dec-12	Marla Bay	19.0	40	7	3	4	0	NA	NA
30-Dec-12	Marla Bay	19.0	50	5	1	4	0	6	3
5-Jan-12	Sand Harbor	22.6	3	0	0	0	0	1	0
5-Jan-12	Sand Harbor	22.5	10	6	6	0	0	1	0
5-Jan-12	Sand Harbor	22.3	20	7	2	5	0	1	0
5-Jan-12	Sand Harbor	22.2	30	12	4	8	0	6	1
5-Jan-12	Sand Harbor	22.0	40	9	1	8	1	7	5
5-Jan-12	Sand Harbor	21.9	50	8	6	2	0	13	2
24-Feb-12	Sand Harbor	20.5	3	0	0	0	0	1	1
24-Feb-12	Sand Harbor	20.5	10	0	0	0	2	2	1
24-Feb-12	Sand Harbor	20.3	20	5	0	5	0	3	0
24-Feb-12	Sand Harbor	20.3	30	0	0	0	0	4	0
24-Feb-12	Sand Harbor	20.1	40	0	0	0	0	6	1
24-Feb-12	Sand Harbor	19.9	50	5	1	4	0	9	2
7-Apr-12	Sand Harbor	22.6	3	0	0	0	1	0	0
7-Apr-12	Sand Harbor	22.6	10	1	1	0	0	0	0
7-Apr-12	Sand Harbor	22.6	20	4	1	3	0	2	0
7-Apr-12	Sand Harbor	22.6	30	0	0	0	0	0	0
7-Apr-12	Sand Harbor	22.6	40	2	1	1	0	5	0
7-Apr-12	Sand Harbor	22.7	50	3	0	3	0	2	0
23-Apr-12	Sand Harbor	22.5	3	0	0	0	1	0	0
23-Apr-12	Sand Harbor	22.5	10	0	0	0	5	1	0
23-Apr-12	Sand Harbor	22.4	20	0	0	0	0	0	0
23-Apr-12	Sand Harbor	22.3	30	0	0	0	0	4	0
23-Apr-12	Sand Harbor	22.2	40	4	0	4	0	1	0
23-Apr-12	Sand Harbor	22.1	50	0	0	0	0	3	2
20-May-12	Sand Harbor	21.3	3	1	1	0	3	1	1
20-May-12	Sand Harbor	21.2	10	3	3	0	0	NA	NA
20-May-12	Sand Harbor	21.0	20	9	4	5	0	8	5
20-May-12	Sand Harbor	21.0	30	5	2	3	0	1	1
20-May-12	Sand Harbor	20.9	40	3	0	3	0	2	1
20-May-12	Sand Harbor	20.7	50	4	0	4	0	2	0
27-Jun-12	Sand Harbor	15.4	3	2	0	2	3	1	0
27-Jun-12	Sand Harbor	15.3	10	24	12	12	0	48	25
27-Jun-12	Sand Harbor	15.1	20	29	15	14	0	41	14
27-Jun-12	Sand Harbor	15.0	30	35	18	17	0	20	11
27-Jun-12	Sand Harbor	14.9	40	18	8	10	0	21	13
27-Jun-12	Sand Harbor	14.9	50	1	1	0	0	5	3
26-Jul-12	Sand Harbor	20.0	3	8	6	2	1	6	3
26-Jul-12	Sand Harbor	19.9	10	19	8	11	0	30	16
26-Jul-12	Sand Harbor	19.8	20	61	31	30	0	67	35
26-Jul-12	Sand Harbor	19.6	30	69	40	29	0	68	27
26-Jul-12	Sand Harbor	19.5	40	17	9	8	0	26	11
26-Jul-12	Sand Harbor	19.4	50	15	8	7	0	36	13
30-Aug-12	Sand Harbor	18.8	3	9	1	8	0	5	2
30-Aug-12	Sand Harbor	18.6	10	23	11	12	0	51	27
30-Aug-12	Sand Harbor	18.5	20	13	2	11	0	56	21
30-Aug-12	Sand Harbor	18.4	30	59	33	26	0	62	28
30-Aug-12	Sand Harbor	18.3	40	26	15	11	0	37	20
30-Aug-12	Sand Harbor	18.3	50	0	0	0	0	0	0
13-Oct-12	Sand Harbor	22.7	3	6	1	5	3	NA	NA
13-Oct-12	Sand Harbor	22.7	10	16	6	10	0	39	23
13-Oct-12	Sand Harbor	22.9	20	56	30	26	0	65	46
13-Oct-12	Sand Harbor	23.0	30	42	NA	13	0	25	10
13-Oct-12	Sand Harbor	23.1	40	39	21	18	0	52	25
13-Oct-12	Sand Harbor	22.2	50	10	6	4	0	2	2
13-Nov-12	Sand Harbor	24.0	3	0	0	0	1	2	1
13-Nov-12	Sand Harbor	24.0	10	5	2	3	0	3	1

13-Nov-12	Sand Harbor	24.8	20	21	6	15	0	29	7
13-Nov-12	Sand Harbor	23.7	30	48	25	23	0	34	9
13-Nov-12	Sand Harbor	23.6	40	38	13	25	0	43	18
13-Nov-12	Sand Harbor	23.4	50	21	9	12	0	31	19
5-Jan-13	Sand Harbor	22.5	3	0	0	0	8	0	0
5-Jan-13	Sand Harbor	22.5	10	1	1	0	0	3	1
5-Jan-13	Sand Harbor	22.4	20	11	5	6	0	22	7
5-Jan-13	Sand Harbor	22.3	30	14	5	9	0	18	5
5-Jan-13	Sand Harbor	22.1	40	11	5	6	0	14	3
5-Jan-13	Sand Harbor	22.1	50	7	1	6	0	16	2
6-Jan-12	Secret Harbor	21.3	3	0	0	0	0	0	0
6-Jan-12	Secret Harbor	21.3	10	2	1	1	0	3	0
6-Jan-12	Secret Harbor	21.2	20	0	0	0	0	0	0
6-Jan-12	Secret Harbor	21.1	30	6	4	2	0	6	1
6-Jan-12	Secret Harbor	21.0	40	7	4	3	0	7	2
6-Jan-12	Secret Harbor	12.3	50	NA	NA	NA	NA	NA	NA
23-Apr-12	Secret Harbor	23.4	3	0	0	0	1	0	0
23-Apr-12	Secret Harbor	23.3	10	1	0	1	2	5	3
23-Apr-12	Secret Harbor	23.2	20	3	0	3	1	0	0
23-Apr-12	Secret Harbor	23.2	30	6	2	4	0	0	0
23-Apr-12	Secret Harbor	23.1	40	2	2	0	0	3	0
23-Apr-12	Secret Harbor	23.0	50	0	0	0	0	0	0
20-May-12	Secret Harbor	21.2	3	4	2	2	2	8	3
20-May-12	Secret Harbor	21.1	10	3	1	2	0	16	7
20-May-12	Secret Harbor	21.0	20	8	3	5	0	11	5
20-May-12	Secret Harbor	20.9	30	7	3	4	0	14	5
20-May-12	Secret Harbor	20.8	40	6	1	5	0	2	0
20-May-12	Secret Harbor	25.1	50	4	1	3	0	4	2
27-Jun-12	Secret Harbor	14.5	3	3	2	1	2	0	0
27-Jun-12	Secret Harbor	14.4	10	16	6	10	0	15	10
27-Jun-12	Secret Harbor	14.3	20	35	9	16	0	28	12
27-Jun-12	Secret Harbor	14.2	30	20	11	9	0	15	6
27-Jun-12	Secret Harbor	14.1	40	4	3	1	0	4	2
27-Jun-12	Secret Harbor	14.0	50	4	1	3	0	13	6
26-Jul-12	Secret Harbor	19.9	3	15	9	6	0	34	20
26-Jul-12	Secret Harbor	19.7	10	31	20	11	0	51	29
26-Jul-12	Secret Harbor	19.4	20	66	31	35	0	73	32
26-Jul-12	Secret Harbor	19.3	30	53	20	33	0	51	22
26-Jul-12	Secret Harbor	19.3	40	34	16	18	0	31	13
26-Jul-12	Secret Harbor	19.2	50	20	10	10	0	11	3
30-Aug-12	Secret Harbor	18.4	3	15	8	7	0	84	44
30-Aug-12	Secret Harbor	18.2	10	39	26	13	0	35	16
30-Aug-12	Secret Harbor	18.1	20	28	20	8	0	46	29
30-Aug-12	Secret Harbor	18.1	30	44	20	24	0	34	13
30-Aug-12	Secret Harbor	17.9	40	15	6	9	0	42	19
30-Aug-12	Secret Harbor	17.8	50	0	0	0	0	0	0
13-Oct-12	Secret Harbor	21.5	3	9	3	6	3	4	3
13-Oct-12	Secret Harbor	21.4	10	23	12	11	0	63	35
13-Oct-12	Secret Harbor	21.3	20	34	17	17	0	44	21
13-Oct-12	Secret Harbor	21.2	30	51	28	23	0	43	26
13-Oct-12	Secret Harbor	21.1	40	31	14	17	0	21	11
13-Oct-12	Secret Harbor	21.0	50	32	13	19	0	17	8
7-Nov-12	Secret Harbor	20.0	3	15	7	8	7	5	1
7-Nov-12	Secret Harbor	20.1	10	17	3	14	0	10	5
7-Nov-12	Secret Harbor	20.1	20	8	2	6	0	13	7
7-Nov-12	Secret Harbor	20.1	30	29	6	23	0	18	8
7-Nov-12	Secret Harbor	20.2	40	21	13	8	0	24	9
7-Nov-12	Secret Harbor	20.2	50	15	9	6	0	26	12
5-Jan-13	Secret Harbor	22.2	3	0	0	0	1	0	0
5-Jan-13	Secret Harbor	22.2	10	0	0	0	0	1	1
5-Jan-13	Secret Harbor	22.2	20	3	1	2	0	3	1
5-Jan-13	Secret Harbor	22.1	30	4	2	2	0	3	2
5-Jan-13	Secret Harbor	22.1	40	11	6	5	0	7	3
5-Jan-13	Secret Harbor	22.0	50	10	6	4	0	11	7

6-Jan-12	Sugar Pine Point	20.5	3	1	1	0	1	1	1
6-Jan-12	Sugar Pine Point	20.5	10	1	1	0	0	2	0
6-Jan-12	Sugar Pine Point	20.4	20	3	2	1	0	1	1
6-Jan-12	Sugar Pine Point	20.4	30	3	2	1	0	1	1
6-Jan-12	Sugar Pine Point	20.4	40	10	5	5	0	7	4
6-Jan-12	Sugar Pine Point	20.3	50	1	1	0	0	0	0
31-May-12	Sugar Pine Point	19.5	3	5	4	1	0	4	3
31-May-12	Sugar Pine Point	19.4	10	5	2	3	0	18	9
31-May-12	Sugar Pine Point	19.3	20	10	2	8	0	7	2
31-May-12	Sugar Pine Point	19.3	30	2	0	2	0	0	0
31-May-12	Sugar Pine Point	19.2	40	4	1	3	0	4	2
31-May-12	Sugar Pine Point	19.2	50	2	1	1	0	0	0
27-Jun-12	Sugar Pine Point	16.8	3	2	1	1	1	1	0
27-Jun-12	Sugar Pine Point	16.8	10	6	0	6	0	9	2
27-Jun-12	Sugar Pine Point	16.7	20	14	6	8	0	14	5
27-Jun-12	Sugar Pine Point	16.6	30	11	6	5	0	20	12
27-Jun-12	Sugar Pine Point	16.6	40	12	4	8	0	12	6
27-Jun-12	Sugar Pine Point	16.5	50	11	4	7	0	4	2
27-Jul-12	Sugar Pine Point	20.4	3	5	3	2	0	20	7
27-Jul-12	Sugar Pine Point	20.1	10	26	11	15	0	20	14
27-Jul-12	Sugar Pine Point	20.0	20	52	28	24	0	28	12
27-Jul-12	Sugar Pine Point	19.8	30	26	18	8	0	69	41
27-Jul-12	Sugar Pine Point	19.8	40	43	19	24	0	43	26
27-Jul-12	Sugar Pine Point	19.6	50	29	24	5	0	11	6
24-Aug-12	Sugar Pine Point	23.2	3	0	0	0	0	0	0
24-Aug-12	Sugar Pine Point	23.1	10	62	38	24	0	NA	~
24-Aug-12	Sugar Pine Point	23.0	20	16	11	5	0	30	16
24-Aug-12	Sugar Pine Point	22.9	30	23	12	11	0	32	20
24-Aug-12	Sugar Pine Point	22.9	40	11	5	6	0	2	1
24-Aug-12	Sugar Pine Point	22.8	50	9	6	3	0	3	0
10-Oct-12	Sugar Pine Point	17.8	3	4	1	3	0	34	25
10-Oct-12	Sugar Pine Point	17.8	10	42	21	21	0	63	34
10-Oct-12	Sugar Pine Point	17.7	20	63	30	33	0	51	23
10-Oct-12	Sugar Pine Point	17.6	30	53	27	26	0	50	26
10-Oct-12	Sugar Pine Point	17.5	40	29	17	12	0	33	19

10-Oct-12	Sugar Pine Point	17.4	50	28	21	7	0	20	10
14-Nov-12	Sugar Pine Point	22.3	3	2	1	1	0	8	2
14-Nov-12	Sugar Pine Point	22.2	10	37	6	31	0	30	11
14-Nov-12	Sugar Pine Point	22.2	20	24	5	19	0	NA	NA
14-Nov-12	Sugar Pine Point	22.2	30	29	4	25	0	30	9
14-Nov-12	Sugar Pine Point	22.1	50	25	5	20	0	14	4
15-Nov-12	Sugar Pine Point	23.8	40	20	5	15	0	15	2
3-Jan-13	Sugar Pine Point	23.3	3	1	1	0	0	0	0
3-Jan-13	Sugar Pine Point	23.3	10	2	2	0	0	0	0
3-Jan-13	Sugar Pine Point	23.2	20	11	2	9	0	11	2
3-Jan-13	Sugar Pine Point	23.1	30	11	6	5	0	18	10
3-Jan-13	Sugar Pine Point	23.0	40	8	4	4	0	15	8
3-Jan-13	Sugar Pine Point	23.1	50	2	1	1	0	6	1
5-Jan-12	Sunnyside	19.0	3	0	0	0	1	0	0
5-Jan-12	Sunnyside	19.0	10	15	1	14	0	9	5
5-Jan-12	Sunnyside	18.9	20	8	1	7	0	5	3
5-Jan-12	Sunnyside	18.9	30	3	1	2	0	0	0
5-Jan-12	Sunnyside	18.8	40	2	0	2	0	6	1
5-Jan-12	Sunnyside	18.7	50	6	1	5	0	11	2
24-Feb-12	Sunnyside	20.1	3	0	0	0	0	0	0
24-Feb-12	Sunnyside	20.1	10	1	0	1	0	1	0
24-Feb-12	Sunnyside	20.0	20	10	5	5	0	2	0
24-Feb-12	Sunnyside	20.0	30	4	2	2	0	3	2
24-Feb-12	Sunnyside	20.0	40	2	1	1	0	1	1
24-Feb-12	Sunnyside	19.9	50	3	1	2	0	6	2
7-Apr-12	Sunnyside	23.0	3	1	0	1	0	0	0
7-Apr-12	Sunnyside	23.0	10	1	0	1	0	0	0
7-Apr-12	Sunnyside	22.9	20	5	2	3	0	0	0
7-Apr-12	Sunnyside	22.9	30	2	0	2	0	0	0
7-Apr-12	Sunnyside	22.9	40	0	0	0	0	1	1
7-Apr-12	Sunnyside	22.8	50	1	1	0	0	1	1
23-Apr-12	Sunnyside	19.5	3	0	0	0	0	0	0
23-Apr-12	Sunnyside	19.5	10	0	0	0	1	2	1
23-Apr-12	Sunnyside	19.4	20	1	0	1	9	0	0
23-Apr-12	Sunnyside	19.4	30	6	1	5	0	0	0
23-Apr-12	Sunnyside	19.3	40	0	0	0	0	0	0
23-Apr-12	Sunnyside	19.3	50	3	0	3	0	0	0
20-May-12	Sunnyside	24.0	3	7	2	5	0	3	1
20-May-12	Sunnyside	24.0	10	7	4	3	0	10	1
20-May-12	Sunnyside	24.0	20	8	1	7	0	7	3
20-May-12	Sunnyside	24.0	30	8	5	3	0	13	3
20-May-12	Sunnyside	24.0	40	12	2	10	0	7	2
20-May-12	Sunnyside	24.0	50	1	0	1	0	10	1
21-Jun-12	Sunnyside	20.7	3	7	3	4	0	3	2
21-Jun-12	Sunnyside	20.7	10	14	7	7	0	11	6
21-Jun-12	Sunnyside	20.6	20	7	5	2	0	10	3
21-Jun-12	Sunnyside	20.6	30	19	5	14	1	24	11
21-Jun-12	Sunnyside	20.6	40	7	3	4	0	2	0
21-Jun-12	Sunnyside	20.5	50	2	0	2	0	9	8
27-Jul-12	Sunnyside	18.6	3	5	4	1	0	6	3
27-Jul-12	Sunnyside	18.5	10	7	5	2	0	39	23
27-Jul-12	Sunnyside	18.5	20	39	17	22	0	19	10
27-Jul-12	Sunnyside	18.5	30	31	22	29	0	52	23

27-Jul-12	Sunnyside	18.5	40	35	17	18	0	19	13
27-Jul-12	Sunnyside	18.4	50	15	11	4	0	1	1
24-Aug-12	Sunnyside	23.6	3	NA	NA	NA	0	NA	NA
24-Aug-12	Sunnyside	23.7	10	NA	NA	NA	0	NA	NA
24-Aug-12	Sunnyside	23.7	20	NA	NA	NA	0	NA	NA
24-Aug-12	Sunnyside	23.7	30	NA	NA	NA	0	NA	NA
24-Aug-12	Sunnyside	23.7	40	NA	NA	NA	0	NA	NA
24-Aug-12	Sunnyside	23.7	50	NA	NA	NA	0	NA	NA
14-Oct-12	Sunnyside	21.1	3	10	3	7	0	6	1
14-Oct-12	Sunnyside	21.1	10	14	11	3	0	3	2
14-Oct-12	Sunnyside	21.0	20	21	18	3	0	14	12
14-Oct-12	Sunnyside	21.0	30	38	23	15	0	35	25
14-Oct-12	Sunnyside	20.9	40	33	24	9	0	68	45
14-Oct-12	Sunnyside	20.8	50	18	15	3	0	30	25
14-Nov-12	Sunnyside	23.0	3	4	3	1	0	9	5
14-Nov-12	Sunnyside	23.0	10	8	4	4	0	11	5
14-Nov-12	Sunnyside	23.1	20	42	17	25	0	37	13
14-Nov-12	Sunnyside	23.1	30	20	10	10	0	49	21
14-Nov-12	Sunnyside	23.0	40	35	15	20	0	60	21
14-Nov-12	Sunnyside	22.9	50	10	3	7	0	53	15
3-Jan-13	Sunnyside	22.5	3	0	0	0	0	0	0
3-Jan-13	Sunnyside	22.4	10	10	4	6	0	9	2
3-Jan-13	Sunnyside	22.4	20	4	2	2	1	1	0
3-Jan-13	Sunnyside	22.3	30	3	3	0	2	23	8
3-Jan-13	Sunnyside	22.3	40	10	4	6	0	2	1
3-Jan-13	Sunnyside	22.2	50	6	1	5	0	10	2
5-Jan-12	Tahoe City	20.3	3	1	0	1	0	0	0
5-Jan-12	Tahoe City	20.1	10	2	1	1	0	0	0
5-Jan-12	Tahoe City	20.0	20	8	5	3	0	6	4
5-Jan-12	Tahoe City	19.8	30	13	5	8	0	34	19
5-Jan-12	Tahoe City	19.8	40	16	6	10	0	31	15
5-Jan-12	Tahoe City	19.6	50	12	4	8	0	41	19
24-Feb-12	Tahoe City	20.2	3	1	1	0	0	0	0
24-Feb-12	Tahoe City	20.1	10	1	0	1	0	0	0
24-Feb-12	Tahoe City	20.0	20	4	4	0	0	3	2
24-Feb-12	Tahoe City	19.9	30	15	6	9	0	5	3
24-Feb-12	Tahoe City	19.8	40	9	2	7	0	24	4
24-Feb-12	Tahoe City	19.7	50	7	3	4	0	7	2
7-Apr-12	Tahoe City	23.0	3	3	1	2	0	0	0
7-Apr-12	Tahoe City	22.9	10	1	0	1	0	0	0
7-Apr-12	Tahoe City	22.8	20	7	2	5	0	7	1
7-Apr-12	Tahoe City	22.7	30	4	1	3	0	8	1
7-Apr-12	Tahoe City	22.6	40	8	2	6	0	10	5
7-Apr-12	Tahoe City	22.5	50	5	3	2	0	6	2
23-Apr-12	Tahoe City	20.3	3	2	0	2	0	0	0
23-Apr-12	Tahoe City	20.2	10	1	0	1	0	0	0
23-Apr-12	Tahoe City	23.9	20	5	1	4	0	4	1
23-Apr-12	Tahoe City	20.1	30	0	0	0	1	2	1
23-Apr-12	Tahoe City	20.0	40	8	4	4	0	12	3
23-Apr-12	Tahoe City	19.9	50	2	0	2	0	7	5
20-May-12	Tahoe City	25.0	3	0	0	0	0	8	5
20-May-12	Tahoe City	24.9	10	19	8	11	0	40	17
20-May-12	Tahoe City	24.8	20	51	17	34	0	66	33
20-May-12	Tahoe City	24.7	30	35	7	28	1	48	16
20-May-12	Tahoe City	24.0	40	15	3	12	0	20	13
20-May-12	Tahoe City	24.5	50	7	1	6	0	4	2
21-Jun-12	Tahoe City	20.7	3	18	11	7	0	13	3
21-Jun-12	Tahoe City	20.6	10	36	19	17	0	43	21
21-Jun-12	Tahoe City	20.4	20	34	19	15	0	27	16
21-Jun-12	Tahoe City	20.1	30	61	24	37	0	53	22
21-Jun-12	Tahoe City	20.0	40	35	10	25	0	27	13
21-Jun-12	Tahoe City	20.0	50	21	5	16	0	24	6
27-Jul-12	Tahoe City	19.2	3	54	22	23	0	45	22
27-Jul-12	Tahoe City	19.1	10	56	34	22	0	50	36

27-Jul-12	Tahoe City	19.0	20	66	28	38	0	64	37
27-Jul-12	Tahoe City	18.8	30	52	35	17	0	9	8
27-Jul-12	Tahoe City	20.6	40	62	34	28	0	51	35
27-Jul-12	Tahoe City	20.5	50	74	54	20	0	65	42
24-Aug-12	Tahoe City	22.8	3	6	1	5	0	43	27
24-Aug-12	Tahoe City	22.9	10	39	20	19	0	28	17
24-Aug-12	Tahoe City	22.9	20	3	1	2	0	38	23
24-Aug-12	Tahoe City	22.9	30	17	12	5	0	36	20
24-Aug-12	Tahoe City	23.0	40	42	31	11	0	49	28
24-Aug-12	Tahoe City	23.0	50	17	10	7	0	1	1
14-Oct-12	Tahoe City	21.0	3	16	7	9	0	21	13
14-Oct-12	Tahoe City	20.9	10	19	15	4	0	71	49
14-Oct-12	Tahoe City	20.8	20	72	36	36	0	93	51
14-Oct-12	Tahoe City	20.5	30	54	24	30	0	63	33
14-Oct-12	Tahoe City	20.3	40	69	43	26	0	20	12
14-Oct-12	Tahoe City	20.1	50	45	34	11	0	40	27
14-Nov-12	Tahoe City	23.3	3	15	8	7	0	24	9
14-Nov-12	Tahoe City	23.4	10	36	19	17	0	14	4
14-Nov-12	Tahoe City	23.3	20	46	17	29	0	47	18
14-Nov-12	Tahoe City	23.1	30	25	10	15	0	42	13
14-Nov-12	Tahoe City	23.2	40	19	10	9	0	3	3
14-Nov-12	Tahoe City	23.1	50	46	13	33	0	44	11
3-Jan-13	Tahoe City	23.5	3	0	0	0	0	0	0
3-Jan-13	Tahoe City	23.3	10	8	5	3	0	13	7
3-Jan-13	Tahoe City	23.2	20	30	11	19	0	32	12
3-Jan-13	Tahoe City	23.1	30	33	12	21	0	12	2
3-Jan-13	Tahoe City	23.0	40	15	5	10	0	18	6
3-Jan-13	Tahoe City	22.9	50	37	10	27	0	22	10
17-Feb-13	Cave Rock	19.1	3	2	1	1	0	0	0
17-Feb-13	Cave Rock	19.2	10	3	3	0	0	0	0
17-Feb-13	Cave Rock	19.2	20	2	0	2	0	2	1
17-Feb-13	Cave Rock	19.3	30	0	0	0	0	0	0
17-Feb-13	Cave Rock	19.3	40	0	0	0	0	0	0
17-Feb-13	Cave Rock	19.4	50	3	0	3	0	3	0
14-Mar-13	Cave Rock	22.0	3	2	2	0	0	1	1
14-Mar-13	Cave Rock	22.0	10	0	0	0	0	1	0
14-Mar-13	Cave Rock	22.0	20	0	0	0	0	0	0
14-Mar-13	Cave Rock	22.1	30	0	0	0	0	1	0
14-Mar-13	Cave Rock	22.4	40	8	3	5	0	2	1
14-Mar-13	Cave Rock	22.4	50	14	1	13	0	10	1
3-May-13	Cave Rock	18.7	3	1	1	0	0	3	1
3-May-13	Cave Rock	18.7	10	19	3	16	1	12	3
3-May-13	Cave Rock	18.6	20	4	1	3	0	1	1
3-May-13	Cave Rock	18.5	30	1	0	1	0	0	0
3-May-13	Cave Rock	18.5	40	1	1	0	0	4	1
3-May-13	Cave Rock	18.4	50	2	2	0	0	3	1
3-Jun-13	Cave Rock	23.7	3	1	0	1	0	0	0
3-Jun-13	Cave Rock	23.7	10	2	0	2	1	3	3
3-Jun-13	Cave Rock	23.6	20	3	3	0	0	5	2
3-Jun-13	Cave Rock	23.5	30	4	0	4	0	5	2
3-Jun-13	Cave Rock	23.4	40	1	0	1	0	4	3
3-Jun-13	Cave Rock	23.4	50	11	4	7	0	8	0
28-Jun-13	Cave Rock	16.2	3	9	9	0	0	NA	NA
28-Jun-13	Cave Rock	16.1	10	28	17	11	1	NA	NA
28-Jun-13	Cave Rock	15.9	20	25	16	9	0	61	32
28-Jun-13	Cave Rock	16.1	30	22	14	8	0	18	8
28-Jun-13	Cave Rock	16.0	40	14	10	4	0	22	16
28-Jun-13	Cave Rock	15.8	50	13	12	1	0	1	0
19-Jul-13	Cave Rock	24.0	3	NA	NA	NA	NA	NA	NA
19-Jul-13	Cave Rock	24.0	10	NA	NA	NA	NA	NA	NA
19-Jul-13	Cave Rock	24.0	20	NA	NA	NA	NA	NA	NA
19-Jul-13	Cave Rock	24.0	30	NA	NA	NA	NA	NA	NA
19-Jul-13	Cave Rock	24.0	40	NA	NA	NA	NA	NA	NA
20-Jul-13	Cave Rock	24.0	50	NA	NA	NA	NA	NA	NA

16-Feb-13	Crystal Bay	25.1	3	0	0	0	0	0	0
16-Feb-13	Crystal Bay	24.9	10	9	3	6	1	8	2
16-Feb-13	Crystal Bay	24.8	20	7	2	5	0	7	3
16-Feb-13	Crystal Bay	24.6	30	17	8	9	0	14	6
16-Feb-13	Crystal Bay	24.5	40	12	4	8	0	29	16
16-Feb-13	Crystal Bay	24.4	50	1	0	1	0	9	6
16-Mar-13	Crystal Bay	20.0	3	0	0	0	2	1	1
16-Mar-13	Crystal Bay	19.8	10	8	2	6	0	4	1
16-Mar-13	Crystal Bay	19.8	20	15	6	9	0	9	5
16-Mar-13	Crystal Bay	19.7	30	7	2	5	0	18	9
16-Mar-13	Crystal Bay	19.7	40	1	1	0	0	0	0
16-Mar-13	Crystal Bay	19.6	50	0	0	0	1	1	0
21-Apr-13	Crystal Bay	23.3	3	3	2	1	0	3	2
21-Apr-13	Crystal Bay	23.1	10	6	4	2	0	NA	NA
21-Apr-13	Crystal Bay	23.0	20	18	9	9	0	15	6
21-Apr-13	Crystal Bay	22.8	30	18	7	11	0	24	10
21-Apr-13	Crystal Bay	22.7	40	2	0	2	0	1	0
21-Apr-13	Crystal Bay	22.5	50	4	2	2	0	5	3
4-Jun-13	Crystal Bay	23.9	3	1	0	1	0	~	~
4-Jun-13	Crystal Bay	23.8	10	7	1	6	0	~	~
4-Jun-13	Crystal Bay	23.7	20	24	5	19	0	21	6
4-Jun-13	Crystal Bay	23.5	30	8	2	6	0	10	3
4-Jun-13	Crystal Bay	23.4	40	7	2	5	0	8	3
4-Jun-13	Crystal Bay	23.1	50	0	0	0	0	1	0
29-Jun-13	Crystal Bay	20.6	3	15	5	10	0	NA	NA
29-Jun-13	Crystal Bay	20.5	10	52	22	30	0	NA	NA
29-Jun-13	Crystal Bay	20.3	20	30	16	14	0	52	35
29-Jun-13	Crystal Bay	20.2	30	59	40	19	0	23	13
29-Jun-13	Crystal Bay	20.1	40	2	0	2	0	0	0
29-Jun-13	Crystal Bay	20.0	50	3	2	1	0	5	3
20-Jul-13	Crystal Bay	22.1	3	6	3	3	0	NA	NA
20-Jul-13	Crystal Bay	22.1	10	51	27	24	0	NA	NA
20-Jul-13	Crystal Bay	22.2	20	55	31	24	0	NA	NA
20-Jul-13	Crystal Bay	22.2	30	33	11	22	0	18	9
20-Jul-13	Crystal Bay	22.3	40	31	15	16	0	36	19
20-Jul-13	Crystal Bay	22.4	50	26	12	14	0	33	13
18-Feb-13	Emerald Bay	20.7	3	2	0	2	1	2	1
18-Feb-13	Emerald Bay	20.7	10	2	0	2	1	3	1
18-Feb-13	Emerald Bay	20.6	20	18	7	11	0	15	1
18-Feb-13	Emerald Bay	20.6	30	10	4	6	0	3	1
18-Feb-13	Emerald Bay	20.5	40	9	6	3	0	16	2
18-Feb-13	Emerald Bay	20.4	50	0	0	0	0	1	0
15-Mar-13	Emerald Bay	23.8	3	3	1	2	0	9	1
15-Mar-13	Emerald Bay	23.8	10	3	0	3	1	6	0
15-Mar-13	Emerald Bay	23.8	20	13	3	10	0	11	3
15-Mar-13	Emerald Bay	23.7	30	3	2	1	0	4	0
15-Mar-13	Emerald Bay	23.7	40	15	4	11	0	12	4
15-Mar-13	Emerald Bay	23.6	50	0	0	0	0	0	0
3-May-13	Emerald Bay	25.1	3	13	1	12	0	12	3
3-May-13	Emerald Bay	25.2	10	16	0	16	0	5	0
3-May-13	Emerald Bay	25.3	20	10	4	6	0	8	3
3-May-13	Emerald Bay	25.4	30	5	1	4	0	3	3
3-May-13	Emerald Bay	25.5	40	1	0	1	0	1	1
3-May-13	Emerald Bay	25.6	50	1	0	1	0	1	0
3-Jun-13	Emerald Bay	25.3	3	8	2	6	0	1	0
3-Jun-13	Emerald Bay	25.3	10	10	4	6	0	1	1
3-Jun-13	Emerald Bay	25.2	20	8	1	7	0	9	5
3-Jun-13	Emerald Bay	25.1	30	1	0	1	0	5	1
3-Jun-13	Emerald Bay	25.0	40	1	0	1	0	2	0
3-Jun-13	Emerald Bay	25.0	50	0	0	0	0	0	0
28-Jun-13	Emerald Bay	12.9	3	5	4	1	5	NA	NA
28-Jun-13	Emerald Bay	12.9	10	9	4	5	0	NA	NA
28-Jun-13	Emerald Bay	12.9	20	13	7	6	0	55	25
28-Jun-13	Emerald Bay	12.8	30	5	4	1	0	2	2

28-Jun-13	Emerald Bay	16.4	40	3	2	1	0	1	1
28-Jun-13	Emerald Bay	12.6	50	1	1	0	0	0	0
19-Jul-13	Emerald Bay	24.0	3	NA	NA	NA	NA	NA	NA
19-Jul-13	Emerald Bay	24.0	10	NA	NA	NA	NA	NA	NA
19-Jul-13	Emerald Bay	24.0	20	NA	NA	NA	NA	NA	NA
19-Jul-13	Emerald Bay	24.0	30	NA	NA	NA	NA	NA	NA
19-Jul-13	Emerald Bay	24.0	40	NA	NA	NA	NA	NA	NA
19-Jul-13	Emerald Bay	24.0	50	NA	NA	NA	NA	NA	NA
16-Feb-13	King's Beach	24.0	3	2	1	1	0	1	1
16-Feb-13	King's Beach	24.0	10	5	2	3	0	17	11
16-Feb-13	King's Beach	23.8	20	11	6	5	0	12	4
16-Feb-13	King's Beach	23.7	30	24	12	12	0	41	17
16-Feb-13	King's Beach	23.5	40	34	2	32	0	23	9
16-Feb-13	King's Beach	23.3	50	50	15	35	0	36	10
16-Mar-13	King's Beach	21.4	3	16	6	10	0	21	7
16-Mar-13	King's Beach	21.3	10	9	4	5	0	11	5
16-Mar-13	King's Beach	21.1	20	31	11	20	0	24	8
16-Mar-13	King's Beach	21.0	30	11	4	5	0	13	1
16-Mar-13	King's Beach	20.9	40	6	1	5	0	13	2
16-Mar-13	King's Beach	20.9	50	9	3	6	0	6	2
21-Apr-13	King's Beach	23.1	3	4	2	2	0	19	7
21-Apr-13	King's Beach	23.1	10	13	8	5	0	9	4
21-Apr-13	King's Beach	23.1	20	3	1	2	0	6	3
21-Apr-13	King's Beach	23.2	30	35	5	30	0	NA	NA
21-Apr-13	King's Beach	23.2	40	12	7	5	0	5	1
21-Apr-13	King's Beach	23.2	50	8	1	7	0	6	2
4-Jun-13	King's Beach	22.9	3	14	9	5	0	~	~
4-Jun-13	King's Beach	22.9	10	6	3	3	4	~	~
4-Jun-13	King's Beach	22.8	20	9	3	6	0	3	2
4-Jun-13	King's Beach	22.7	30	37	7	30	0	26	4
4-Jun-13	King's Beach	22.6	40	20	9	11	0	18	6
4-Jun-13	King's Beach	22.5	50	7	3	4	0	7	3
29-Jun-13	Kings Beach	21.3	3	12	4	8	0	9	2
29-Jun-13	Kings Beach	21.1	10	20	12	8	1	19	10
29-Jun-13	Kings Beach	21.0	20	38	25	13	1	35	15
29-Jun-13	Kings Beach	20.8	30	21	10	11	0	32	16
29-Jun-13	Kings Beach	20.7	40	22	16	6	0	19	9
29-Jun-13	Kings Beach	20.5	50	9	3	6	0	15	7
20-Jul-13	Kings Beach	24.0	3	NA	NA	NA	NA	NA	NA
20-Jul-13	Kings Beach	24.0	10	NA	NA	NA	NA	NA	NA
20-Jul-13	Kings Beach	24.0	20	NA	NA	NA	NA	NA	NA
20-Jul-13	Kings Beach	24.0	30	NA	NA	NA	NA	NA	NA
20-Jul-13	Kings Beach	24.0	40	NA	NA	NA	NA	NA	NA
20-Jul-13	Kings Beach	24.0	50	NA	NA	NA	NA	NA	NA
18-Feb-13	Marla Bay	20.5	3	0	0	0	0	0	0
18-Feb-13	Marla Bay	20.4	10	1	0	1	0	2	0
18-Feb-13	Marla Bay	20.4	20	0	0	0	0	1	0
18-Feb-13	Marla Bay	20.3	30	1	0	1	0	0	0
18-Feb-13	Marla Bay	20.3	40	7	1	6	0	0	0
18-Feb-13	Marla Bay	20.2	50	5	0	5	0	5	4
14-Mar-13	Marla Bay	23.0	3	0	0	0	0	0	0
14-Mar-13	Marla Bay	22.9	10	0	0	0	0	0	0
14-Mar-13	Marla Bay	22.8	20	2	2	0	0	0	0
14-Mar-13	Marla Bay	22.8	30	0	0	0	0	6	1
14-Mar-13	Marla Bay	22.7	40	2	1	1	0	0	0
14-Mar-13	Marla Bay	22.6	50	1	0	1	0	3	1
3-May-13	Marla Bay	18.6	3	0	0	0	0	0	0
3-May-13	Marla Bay	18.5	10	7	0	7	1	NA	NA
3-May-13	Marla Bay	18.4	20	2	0	2	0	1	0
3-May-13	Marla Bay	18.4	30	1	1	0	0	0	0
3-May-13	Marla Bay	18.3	40	0	0	0	0	3	1
3-May-13	Marla Bay	18.3	50	0	0	0	0	0	0
3-Jun-13	Marla Bay	23.7	3	0	0	0	1	0	0
3-Jun-13	Marla Bay	23.5	10	3	2	1	3	0	0

3-Jun-13	Marla Bay	23.5	20	7	0	7	1	8	1
3-Jun-13	Marla Bay	23.4	30	2	0	2	0	1	0
3-Jun-13	Marla Bay	23.4	40	0	0	0	0	0	0
3-Jun-13	Marla Bay	23.4	50	0	0	0	0	0	0
28-Jun-13	Marla Bay	17.2	3	0	0	0	0	NA	NA
28-Jun-13	Marla Bay	17.2	10	24	17	7	0	NA	NA
28-Jun-13	Marla Bay	17.1	20	1	1	0	2	3	1
28-Jun-13	Marla Bay	17.0	30	5	5	0	0	1	1
28-Jun-13	Marla Bay	17.0	40	0	0	0	0	4	1
28-Jun-13	Marla Bay	17.0	50	0	0	0	0	1	1
20-Jul-13	Marla Bay	24.0	3	NA	NA	NA	NA	NA	NA
20-Jul-13	Marla Bay	24.0	10	NA	NA	NA	NA	NA	NA
20-Jul-13	Marla Bay	24.0	20	NA	NA	NA	NA	NA	NA
20-Jul-13	Marla Bay	24.0	30	NA	NA	NA	NA	NA	NA
20-Jul-13	Marla Bay	24.0	40	NA	NA	NA	NA	NA	NA
20-Jul-13	Marla Bay	24.0	50	NA	NA	NA	NA	NA	NA
17-Feb-13	Sand Harbor	21.4	3	0	0	0	2	0	0
17-Feb-13	Sand Harbor	21.3	10	0	0	0	1	6	2
17-Feb-13	Sand Harbor	21.2	20	4	1	3	0	8	4
17-Feb-13	Sand Harbor	21.1	30	7	5	2	0	10	4
17-Feb-13	Sand Harbor	21.0	40	11	1	10	0	11	2
17-Feb-13	Sand Harbor	21.0	50	6	3	3	0	5	2
15-Mar-13	Sand Harbor	24.8	3	0	0	0	1	0	0
15-Mar-13	Sand Harbor	24.7	10	1	0	1	0	0	0
15-Mar-13	Sand Harbor	24.7	20	1	0	1	0	3	0
15-Mar-13	Sand Harbor	24.6	30	5	0	5	1	2	1
15-Mar-13	Sand Harbor	24.6	40	3	0	3	0	4	1
15-Mar-13	Sand Harbor	24.5	50	9	2	7	0	4	1
3-May-13	Sand Harbor	21.0	3	1	0	1	NA	0	0
3-May-13	Sand Harbor	21.0	10	9	3	6	1	0	0
3-May-13	Sand Harbor	20.9	20	6	1	5	NA	2	0
3-May-13	Sand Harbor	20.8	30	4	1	3	NA	8	2
3-May-13	Sand Harbor	20.8	40	5	3	2	NA	3	0
3-May-13	Sand Harbor	20.7	50	1	0	1	NA	5	0
4-Jun-13	Sand Harbor	23.2	3	0	0	0	1	~	~
4-Jun-13	Sand Harbor	23.1	10	8	2	6	0	~	~
4-Jun-13	Sand Harbor	23.0	20	3	2	1	0	2	1
4-Jun-13	Sand Harbor	22.9	30	9	2	7	0	8	2
4-Jun-13	Sand Harbor	22.8	40	6	3	3	0	17	11
4-Jun-13	Sand Harbor	22.8	50	3	2	1	0	1	1
29-Jun-13	Sand Harbor	19.0	3	1	NA	1	0	NA	NA
29-Jun-13	Sand Harbor	18.8	10	24	17	7	0	NA	NA
29-Jun-13	Sand Harbor	18.7	20	30	13	17	0	39	18
29-Jun-13	Sand Harbor	18.5	30	27	20	7	0	37	24
29-Jun-13	Sand Harbor	18.4	40	0	0	0	0	20	13
29-Jun-13	Sand Harbor	18.2	50	8	5	3	0	1	1
19-Jul-13	Sand Harbor	24.0	3	NA	NA	NA	NA	NA	NA
19-Jul-13	Sand Harbor	24.0	10	NA	NA	NA	NA	NA	NA
19-Jul-13	Sand Harbor	24.0	20	NA	NA	NA	NA	NA	NA
19-Jul-13	Sand Harbor	24.0	30	NA	NA	NA	NA	NA	NA
19-Jul-13	Sand Harbor	24.0	40	NA	NA	NA	NA	NA	NA
19-Jul-13	Sand Harbor	24.0	50	NA	NA	NA	NA	NA	NA
17-Feb-13	Secret Harbor	20.6	3	1	0	1	4	1	0
17-Feb-13	Secret Harbor	20.5	10	2	1	1	0	1	0
17-Feb-13	Secret Harbor	20.4	20	5	3	2	0	4	2
17-Feb-13	Secret Harbor	20.3	30	0	0	0	0	4	2
17-Feb-13	Secret Harbor	20.3	40	5	1	4	0	8	3
17-Feb-13	Secret Harbor	20.2	50	7	5	2	0	4	1
15-Mar-13	Secret Harbor	24.9	3	0	0	0	0	NA	NA
15-Mar-13	Secret Harbor	24.8	10	6	2	4	0	1	1
15-Mar-13	Secret Harbor	24.7	20	2	2	0	0	1	0
15-Mar-13	Secret Harbor	24.6	30	9	5	4	0	6	2
15-Mar-13	Secret Harbor	24.5	40	0	0	0	0	3	1
15-Mar-13	Secret Harbor	24.3	50	9	2	7	0	3	2

3-May-13	Secret Harbor	20.3	3	2	1	1	15	4	1
3-May-13	Secret Harbor	20.3	10	1	1	0	0	0	0
3-May-13	Secret Harbor	20.2	20	6	4	2	0	9	1
3-May-13	Secret Harbor	20.1	30	5	0	5	0	5	0
3-May-13	Secret Harbor	20.0	40	2	1	1	0	7	2
3-May-13	Secret Harbor	20.0	50	8	4	4	0	5	0
4-Jun-13	Secret Harbor	22.8	3	0	0	0	0	0	0
4-Jun-13	Secret Harbor	22.8	10	3	0	3	0	3	1
4-Jun-13	Secret Harbor	22.7	20	7	2	5	0	10	3
4-Jun-13	Secret Harbor	22.7	30	17	2	15	0	7	3
4-Jun-13	Secret Harbor	22.6	40	8	6	2	0	11	4
4-Jun-13	Secret Harbor	22.6	50	8	3	5	0	0	0
29-Jun-13	Secret Harbor	19.1	3	0	0	0	2	NA	NA
29-Jun-13	Secret Harbor	19.1	10	7	2	5	1	NA	NA
29-Jun-13	Secret Harbor	19.1	20	18	12	6	0	53	33
29-Jun-13	Secret Harbor	19.0	30	35	22	13	0	8	5
29-Jun-13	Secret Harbor	18.9	40	14	6	8	0	15	8
29-Jun-13	Secret Harbor	18.8	50	7	3	4	0	6	5
19-Jul-13	Secret Harbor	24.0	3	NA	NA	NA	NA	NA	NA
19-Jul-13	Secret Harbor	24.0	10	NA	NA	NA	NA	NA	NA
19-Jul-13	Secret Harbor	24.0	20	NA	NA	NA	NA	NA	NA
19-Jul-13	Secret Harbor	24.0	30	NA	NA	NA	NA	NA	NA
19-Jul-13	Secret Harbor	24.0	40	NA	NA	NA	NA	NA	NA
19-Jul-13	Secret Harbor	24.0	50	NA	NA	NA	NA	NA	NA
18-Feb-13	Sugar Pine Point	20.7	3	0	0	0	0	5	2
18-Feb-13	Sugar Pine Point	20.6	10	0	0	0	0	0	0
18-Feb-13	Sugar Pine Point	20.5	20	0	0	0	0	1	0
18-Feb-13	Sugar Pine Point	20.4	30	3	0	3	0	4	1
18-Feb-13	Sugar Pine Point	20.4	40	2	0	2	0	6	0
18-Feb-13	Sugar Pine Point	20.3	50	1	0	1	0	1	0
16-Mar-13	Sugar Pine Point	24.0	3	2	1	1	0	0	0
16-Mar-13	Sugar Pine Point	23.9	10	1	0	1	0	1	0
16-Mar-13	Sugar Pine Point	23.9	20	1	1	0	0	1	1
16-Mar-13	Sugar Pine Point	23.8	30	1	0	1	0	1	1
16-Mar-13	Sugar Pine Point	23.8	40	4	0	4	0	1	0
16-Mar-13	Sugar Pine Point	23.7	50	3	1	2	0	6	2
3-May-13	Sugar Pine Point	24.9	3	2	1	1	0	4	4
3-May-13	Sugar Pine Point	24.9	10	11	1	10	0	5	1
3-May-13	Sugar Pine Point	24.8	20	0	0	0	0	5	2
3-May-13	Sugar Pine Point	24.8	30	1	1	0	0	4	1
3-May-13	Sugar Pine Point	24.8	40	10	3	7	0	10	2
3-May-13	Sugar Pine Point	24.7	50	8	4	4	0	4	2
25-May-13	Sugar Pine Point	19.3	3	3	1	2	0	0	0
25-May-13	Sugar Pine Point	19.2	10	1	0	1	0	1	0
25-May-13	Sugar Pine Point	19.1	20	4	0	4	0	3	1
25-May-13	Sugar Pine Point	19.1	30	8	1	7	0	6	1

25-May-13	Sugar Pine Point	19.0	40	7	1	6	0	4	0
25-May-13	Sugar Pine Point	19.0	50	5	1	4	0	3	2
28-Jun-13	Sugar Pine Point	14.7	3	3	1	2	0	NA	NA
28-Jun-13	Sugar Pine Point	14.7	10	39	26	13	0	NA	NA
28-Jun-13	Sugar Pine Point	14.5	20	29	19	10	0	44	18
28-Jun-13	Sugar Pine Point	14.5	30	26	13	13	0	15	7
28-Jun-13	Sugar Pine Point	14.4	40	5	4	1	0	11	1
28-Jun-13	Sugar Pine Point	14.3	50	0	0	0	0	1	0
19-Jul-13	Sugar Pine Point	23.1	3	11	3	8	0	NA	NA
19-Jul-13	Sugar Pine Point	23.1	10	4	1	3	0	NA	NA
19-Jul-13	Sugar Pine Point	23.1	20	18	6	12	0	NA	NA
19-Jul-13	Sugar Pine Point	23.1	30	25	10	15	0	22	11
19-Jul-13	Sugar Pine Point	23.1	40	24	13	11	0	26	15
19-Jul-13	Sugar Pine Point	23.1	50	28	15	13	0	27	12
16-Feb-13	Sunnyside	21.5	3	0	0	0	0	0	0
16-Feb-13	Sunnyside	21.4	10	10	3	7	0	7	2
16-Feb-13	Sunnyside	21.3	20	6	3	3	0	NA	NA
16-Feb-13	Sunnyside	21.3	30	11	4	7	1	7	2
16-Feb-13	Sunnyside	21.1	40	10	4	6	0	2	1
16-Feb-13	Sunnyside	21.1	50	8	2	6	0	6	4
16-Mar-13	Sunnyside	20.0	3	0	0	0	0	0	0
16-Mar-13	Sunnyside	20.0	10	13	5	8	0	7	3
16-Mar-13	Sunnyside	19.9	20	6	4	2	0	8	2
16-Mar-13	Sunnyside	19.8	30	15	6	9	0	9	2
16-Mar-13	Sunnyside	19.7	40	5	0	5	1	2	1
16-Mar-13	Sunnyside	19.7	50	7	0	7	0	2	0
21-Apr-13	Sunnyside	24.1	3	0	0	0	1	0	0
21-Apr-13	Sunnyside	24.0	10	5	1	4	0	9	2
21-Apr-13	Sunnyside	23.9	20	4	1	3	0	10	0
21-Apr-13	Sunnyside	23.7	30	5	2	3	0	10	1
21-Apr-13	Sunnyside	23.7	40	3	0	3	0	11	2
21-Apr-13	Sunnyside	23.6	50	11	2	9	0	2	2
25-May-13	Sunnyside	24.4	3	3	1	2	4	~	~
25-May-13	Sunnyside	21.5	10	8	1	7	1	7	0
25-May-13	Sunnyside	21.3	20	16	8	8	2	12	3
25-May-13	Sunnyside	21.2	30	15	3	12	0	4	1
25-May-13	Sunnyside	21.0	40	8	3	5	0	8	2
25-May-13	Sunnyside	20.9	50	10	3	7	0	6	2
3-Jul-13	Sunnyside	19.5	3	15	3	12	0	NA	NA
3-Jul-13	Sunnyside	19.6	10	9	4	5	0	NA	NA
3-Jul-13	Sunnyside	19.7	20	5	0	5	0	18	8
3-Jul-13	Sunnyside	19.7	30	17	12	5	0	10	5
3-Jul-13	Sunnyside	19.8	40	6	5	1	0	5	4
3-Jul-13	Sunnyside	19.8	50	15	9	6	0	4	4
19-Jul-13	Sunnyside	24.0	3	11	6	5	0	NA	NA
19-Jul-13	Sunnyside	23.9	10	7	2	5	0	NA	NA
19-Jul-13	Sunnyside	23.9	20	3	2	1	0	NA	NA
19-Jul-13	Sunnyside	23.9	30	39	18	21	0	NA	NA
19-Jul-13	Sunnyside	23.9	40	48	23	25	0	31	19
19-Jul-13	Sunnyside	23.8	50	34	19	15	0	45	25
16-Feb-13	Tahoe City	21.9	3	0	0	0	0	0	0
16-Feb-13	Tahoe City	21.9	10	1	1	0	0	0	0

16-Feb-13	Tahoe City	24.3	20	20	5	15	0	23	14
16-Feb-13	Tahoe City	24.5	30	3	0	3	0	11	2
16-Feb-13	Tahoe City	21.7	40	28	5	23	0	1	1
16-Feb-13	Tahoe City	21.5	50	20	4	16	0	43	11
16-Mar-13	Tahoe City	20.4	3	0	0	0	0	2	0
16-Mar-13	Tahoe City	20.2	10	3	2	1	0	6	2
16-Mar-13	Tahoe City	20.1	20	25	9	16	0	28	15
16-Mar-13	Tahoe City	20.1	30	4	1	3	0	17	4
16-Mar-13	Tahoe City	20.0	40	7	2	5	1	32	9
16-Mar-13	Tahoe City	19.8	50	7	1	6	0	11	4
21-Apr-13	Tahoe City	23.4	3	1	1	0	0	NA	NA
21-Apr-13	Tahoe City	23.3	10	8	2	6	0	10	5
21-Apr-13	Tahoe City	23.1	20	11	8	3	0	15	6
21-Apr-13	Tahoe City	23.0	30	2	1	1	0	7	4
21-Apr-13	Tahoe City	22.9	40	14	4	10	0	9	2
21-Apr-13	Tahoe City	22.8	50	13	6	7	0	14	2
25-May-13	Tahoe City	22.8	3	5	4	1	0	17	11
25-May-13	Tahoe City	22.7	10	29	15	14	0	11	6
25-May-13	Tahoe City	22.6	20	41	8	33	0	35	17
25-May-13	Tahoe City	22.5	30	25	8	17	0	35	9
25-May-13	Tahoe City	22.4	40	19	7	12	0	1	0
25-May-13	Tahoe City	22.4	50	13	3	10	0	37	17
3-Jul-13	Tahoe City	20.7	3	2	1	1	0	NA	NA
3-Jul-13	Tahoe City	20.7	10	13	8	5	0	NA	NA
3-Jul-13	Tahoe City	20.8	20	31	15	16	0	22	10
3-Jul-13	Tahoe City	20.8	30	26	9	17	0	29	12
3-Jul-13	Tahoe City	20.8	40	24	9	15	0	26	10
3-Jul-13	Tahoe City	20.8	50	21	12	9	0	6	4
19-Jul-13	Tahoe City	24.0	3	52	23	29	0	NA	NA
19-Jul-13	Tahoe City	24.0	10	20	14	6	0	NA	NA
19-Jul-13	Tahoe City	23.9	20	14	6	8	0	NA	NA
19-Jul-13	Tahoe City	23.7	30	55	32	22	0	NA	NA
19-Jul-13	Tahoe City	23.6	40	22	16	6	0	NA	NA
19-Jul-13	Tahoe City	23.4	50	62	25	37	0	NA	NA
1-Jul-14	Cave Rock	19.3	3	0	0	0	5	NA	NA
1-Jul-14	Cave Rock	19.2	10	76	43	33	2	NA	NA
1-Jul-14	Cave Rock	19.1	20	44	26	18	0	NA	NA
1-Jul-14	Cave Rock	19.0	30	42	30	12	0	70	36
1-Jul-14	Cave Rock	18.9	40	54	37	17	0	35	22
1-Jul-14	Cave Rock	18.8	50	14	11	3	0	7	3
11-Aug-14	Cave Rock	26.5	3	2	1	1	2	NA	NA
11-Aug-14	Cave Rock	26.4	10	8	3	5	1	NA	NA
11-Aug-14	Cave Rock	26.3	20	30	17	13	0	NA	NA
11-Aug-14	Cave Rock	26.2	30	84	50	34	0	NA	NA
11-Aug-14	Cave Rock	26.1	40	52	29	23	0	NA	NA
11-Aug-14	Cave Rock	25.5	50	26	17	9	0	NA	NA
26-Sep-14	Cave Rock	21.6	3	6	3	3	1	NA	NA
26-Sep-14	Cave Rock	21.6	10	6	4	2	6	NA	NA
26-Sep-14	Cave Rock	21.7	20	26	13	13	5	NA	NA
26-Sep-14	Cave Rock	21.7	30	66	38	28	0	NA	NA
26-Sep-14	Cave Rock	21.7	40	53	34	19	0	NA	NA
26-Sep-14	Cave Rock	21.8	50	43	33	10	0	NA	NA
21-Oct-14	Cave Rock	24.1	3	6	2	4	3	NA	NA
21-Oct-14	Cave Rock	24.1	10	4	1	3	3	NA	NA
21-Oct-14	Cave Rock	24.1	20	14	5	9	0	NA	NA
21-Oct-14	Cave Rock	24.1	30	16	7	9	0	19	8
21-Oct-14	Cave Rock	24.2	40	8	3	5	0	7	2
21-Oct-14	Cave Rock	24.3	50	11	6	5	0	15	7
24-Feb-14	Crystal Bay	20.7	3	0	0	0	0	NA	NA
24-Feb-14	Crystal Bay	20.7	10	2	1	1	0	NA	NA
24-Feb-14	Crystal Bay	20.7	20	7	2	5	0	11	5
24-Feb-14	Crystal Bay	20.7	30	9	3	6	0	6	1
24-Feb-14	Crystal Bay	20.7	40	5	1	4	0	0	0
24-Feb-14	Crystal Bay	20.8	50	1	0	1	0	1	0

22-Apr-14	Crystal Bay	22.8	3	1	0	1	0	NA	NA
22-Apr-14	Crystal Bay	22.8	10	4	3	1	0	NA	NA
22-Apr-14	Crystal Bay	22.9	20	4	2	2	0	NA	NA
22-Apr-14	Crystal Bay	23.0	30	9	5	4	0	11	6
22-Apr-14	Crystal Bay	23.0	40	8	5	3	0	12	5
22-Apr-14	Crystal Bay	23.1	50	6	2	4	0	9	5
2-Jul-14	Crystal Bay	21.3	3	16	6	10	4	NA	NA
2-Jul-14	Crystal Bay	21.2	10	50	14	36	0	NA	NA
2-Jul-14	Crystal Bay	21.2	20	72	31	41	0	50	26
2-Jul-14	Crystal Bay	21.0	30	55	30	25	0	71	35
2-Jul-14	Crystal Bay	20.9	40	12	7	5	0	7	3
2-Jul-14	Crystal Bay	20.9	50	6	2	4	0	4	4
8-Aug-14	Crystal Bay	22.1	3	6	3	3	0	NA	NA
8-Aug-14	Crystal Bay	22.1	10	51	27	24	0	NA	NA
8-Aug-14	Crystal Bay	22.2	20	55	31	24	0	NA	NA
8-Aug-14	Crystal Bay	22.2	30	33	11	22	0	18	9
8-Aug-14	Crystal Bay	22.3	40	31	15	16	0	36	19
8-Aug-14	Crystal Bay	22.4	50	26	12	14	0	33	13
25-Sep-14	Crystal Bay	23.5	3	3	2	1	0	NA	NA
25-Sep-14	Crystal Bay	23.5	10	37	10	27	0	NA	NA
25-Sep-14	Crystal Bay	20.5	20	10	6	4	0	NA	NA
25-Sep-14	Crystal Bay	23.5	30	28	18	10	0	NA	NA
25-Sep-14	Crystal Bay	23.5	40	44	25	19	0	NA	NA
25-Sep-14	Crystal Bay	23.4	50	14	8	6	0	NA	NA
15-Oct-14	Crystal Bay	23.1	3	19	11	8	0	NA	NA
15-Oct-14	Crystal Bay	23.1	10	12	7	5	0	NA	NA
15-Oct-14	Crystal Bay	23.1	20	24	11	13	0	NA	NA
15-Oct-14	Crystal Bay	23.2	30	58	25	33	0	66	35
15-Oct-14	Crystal Bay	23.2	40	21	9	12	0	16	8
15-Oct-14	Crystal Bay	23.3	50	10	4	6	0	8	4
2-Jul-14	Emerald Bay	20.8	3	2	1	1	0	NA	NA
2-Jul-14	Emerald Bay	20.8	10	12	8	4	0	NA	NA
2-Jul-14	Emerald Bay	20.8	20	5	2	3	0	NA	NA
2-Jul-14	Emerald Bay	20.8	30	7	4	3	0	9	6
2-Jul-14	Emerald Bay	20.8	40	3	2	1	0	2	2
2-Jul-14	Emerald Bay	20.8	50	0	0	0	0	0	0
9-Aug-14	Emerald Bay	21.5	3	24	16	8	0	NA	NA
9-Aug-14	Emerald Bay	21.4	10	28	16	12	0	NA	NA
9-Aug-14	Emerald Bay	21.3	20	18	8	10	0	NA	NA
9-Aug-14	Emerald Bay	21.2	30	7	2	5	0	16	6
9-Aug-14	Emerald Bay	21.2	40	17	8	9	0	NA	NA
9-Aug-14	Emerald Bay	21.1	0	0	0	0	0	0	0
24-Sep-14	Emerald Bay	23.1	3	6	5	1	0	NA	NA
24-Sep-14	Emerald Bay	23.1	10	30	11	19	0	NA	NA
24-Sep-14	Emerald Bay	23.1	20	17	8	9	0	NA	NA
24-Sep-14	Emerald Bay	23.1	30	31	18	12	0	NA	NA
24-Sep-14	Emerald Bay	23.1	40	23	16	7	0	28	17
24-Sep-14	Emerald Bay	23.1	50	4	1	3	0	8	4
21-Oct-14	Emerald Bay	24.2	3	18	6	12	0	NA	NA
21-Oct-14	Emerald Bay	24.2	10	15	7	8	0	NA	NA
21-Oct-14	Emerald Bay	24.2	20	19	10	9	0	NA	NA
21-Oct-14	Emerald Bay	24.2	30	24	8	16	0	6	2
21-Oct-14	Emerald Bay	24.2	40	9	4	5	0	11	4
21-Oct-14	Emerald Bay	24.1	50	4	3	1	0	2	2
2-Jul-14	Meeks Point	20.8	3	2	2	0	0	NA	NA
2-Jul-14	Meeks Point	20.8	10	14	3	11	0	NA	NA
2-Jul-14	Meeks Point	20.8	20	21	9	12	0	NA	NA
2-Jul-14	Meeks Point	20.8	30	36	19	17	0	31	19
2-Jul-14	Meeks Point	20.8	40	42	21	21	0	37	17
2-Jul-14	Meeks Point	20.8	50	20	17	3	0	16	12
8-Aug-14	Meeks Point	23.2	3	0	0	0	0	NA	NA
8-Aug-14	Meeks Point	23.2	10	19	6	13	0	NA	NA
8-Aug-14	Meeks Point	23.1	20	13	10	3	0	NA	NA
8-Aug-14	Meeks Point	23.1	30	42	23	19	0	28	12

8-Aug-14	Meeks Point	23.0	40	33	18	15	0	20	9
8-Aug-14	Meeks Point	22.9	50	8	4	4	0	36	20
24-Sep-14	Meeks Point	23.2	3	7	5	2	0	NA	NA
24-Sep-14	Meeks Point	23.3	10	8	7	1	0	NA	NA
24-Sep-14	Meeks Point	23.2	20	37	17	20	0	NA	NA
24-Sep-14	Meeks Point	23.2	30	36	20	16	0	NA	NA
24-Sep-14	Meeks Point	23.2	40	23	16	7	0	24	15
24-Sep-14	Meeks Point	23.2	50	34	25	9	0	39	27
21-Oct-14	Meeks Point	23.9	3	9	6	3	0	NA	NA
21-Oct-14	Meeks Point	23.9	10	11	9	2	0	NA	NA
21-Oct-14	Meeks Point	24.0	20	41	18	23	0	NA	NA
21-Oct-14	Meeks Point	24.0	30	45	26	19	0	38	20
21-Oct-14	Meeks Point	24.0	40	24	17	7	0	33	19
21-Oct-14	Meeks Point	24.0	50	29	19	10	0	40	23
2-Jul-14	Sand Harbor	21.2	3	2	0	2	0	NA	NA
2-Jul-14	Sand Harbor	21.1	10	7	4	3	0	NA	NA
2-Jul-14	Sand Harbor	21.0	20	14	6	8	0	14	8
2-Jul-14	Sand Harbor	20.9	30	22	13	9	0	24	16
2-Jul-14	Sand Harbor	20.8	40	17	15	2	0	14	10
2-Jul-14	Sand Harbor	20.7	50	7	4	3	0	2	2
8-Aug-14	Sand Harbor	21.0	3	19	11	8	0	NA	NA
8-Aug-14	Sand Harbor	21.0	10	20	12	8	0	NA	NA
8-Aug-14	Sand Harbor	21.0	20	27	14	13	0	NA	NA
8-Aug-14	Sand Harbor	21.1	30	37	20	17	0	NA	NA
8-Aug-14	Sand Harbor	21.2	40	47	20	27	0	NA	NA
8-Aug-14	Sand Harbor	21.4	50	17	7	10	0	NA	NA
25-Sep-14	Sand Harbor	20.7	3	5	3	2	0	NA	NA
25-Sep-14	Sand Harbor	20.7	10	8	6	2	12	NA	NA
25-Sep-14	Sand Harbor	20.7	20	33	20	13	0	NA	NA
25-Sep-14	Sand Harbor	20.7	30	58	3	27	0	NA	NA
25-Sep-14	Sand Harbor	20.6	40	68	34	34	0	NA	NA
25-Sep-14	Sand Harbor	20.6	50	7	4	3	0	NA	NA
15-Oct-14	Sand Harbor	21.8	3	13	2	11	0	NA	NA
15-Oct-14	Sand Harbor	21.7	10	28	12	16	11	NA	NA
15-Oct-14	Sand Harbor	21.6	20	64	41	23	3	NA	NA
15-Oct-14	Sand Harbor	21.6	30	51	30	21	0	48	29
15-Oct-14	Sand Harbor	21.7	40	40	19	21	0	58	26
15-Oct-14	Sand Harbor	21.8	50	8	6	2	0	12	10
1-Jul-14	Secret Harbor	18.3	3	10	5	5	4	NA	NA
1-Jul-14	Secret Harbor	18.4	10	12	6	6	0	NA	NA
1-Jul-14	Secret Harbor	18.4	20	46	31	15	2	NA	NA
1-Jul-14	Secret Harbor	18.5	30	32	22	10	0	30	16
1-Jul-14	Secret Harbor	18.6	40	20	12	8	0	12	8
1-Jul-14	Secret Harbor	18.6	50	4	2	2	0	16	12
8-Aug-14	Secret Harbor	20.7	3	11	5	6	0	NA	NA
8-Aug-14	Secret Harbor	20.7	10	17	14	3	1	NA	NA
8-Aug-14	Secret Harbor	20.7	20	14	4	10	0	NA	NA
8-Aug-14	Secret Harbor	20.6	30	49	23	26	0	28	10
8-Aug-14	Secret Harbor	20.5	40	32	17	15	0	6	1
8-Aug-14	Secret Harbor	20.5	50	4	2	2	0	24	15
26-Sep-14	Secret Harbor	23.0	3	5	1	4	0	NA	NA
26-Sep-14	Secret Harbor	23.0	10	4	1	3	0	NA	NA
26-Sep-14	Secret Harbor	23.0	20	30	17	13	0	NA	NA
26-Sep-14	Secret Harbor	23.0	30	80	43	37	0	NA	NA
26-Sep-14	Secret Harbor	23.0	40	72	37	35	0	NA	NA
26-Sep-14	Secret Harbor	23.0	50	26	15	11	0	NA	NA
15-Oct-14	Secret Harbor	21.5	3	7	2	5	0	NA	NA
15-Oct-14	Secret Harbor	21.5	10	25	3	22	0	NA	NA
15-Oct-14	Secret Harbor	21.5	20	31	14	17	0	NA	NA
15-Oct-14	Secret Harbor	21.5	30	47	22	25	0	51	28
15-Oct-14	Secret Harbor	21.6	40	28	21	7	0	33	19
15-Oct-14	Secret Harbor	21.6	50	24	10	14	0	12	7
24-Feb-14	Sugar Pine Point	20.5	3	0	0	0	0	NA	NA

24-Feb-14	Sugar Pine Point	20.5	10	2	0	2	0	NA	NA
24-Feb-14	Sugar Pine Point	20.5	20	6	2	4	0	9	4
24-Feb-14	Sugar Pine Point	20.6	30	9	4	5	0	13	3
24-Feb-14	Sugar Pine Point	20.5	40	1	1	0	0	0	0
24-Feb-14	Sugar Pine Point	20.6	50	1	0	1	0	2	0
23-Apr-14	Sugar Pine Point	24.8	3	4	0	4	0	NA	NA
23-Apr-14	Sugar Pine Point	24.8	10	3	1	2	0	NA	NA
23-Apr-14	Sugar Pine Point	24.8	20	8	2	6	0	NA	NA
23-Apr-14	Sugar Pine Point	24.9	30	9	6	3	0	10	2
23-Apr-14	Sugar Pine Point	24.9	40	6	1	5	0	7	1
23-Apr-14	Sugar Pine Point	25.0	50	3	2	1	0	5	3
1-Jul-14	Sugar Pine Point	17.7	3	7	4	3	0	NA	NA
1-Jul-14	Sugar Pine Point	17.7	10	13	1	12	0	NA	NA
1-Jul-14	Sugar Pine Point	17.6	20	31	14	17	0	45	24
1-Jul-14	Sugar Pine Point	17.4	30	38	23	15	0	32	24
1-Jul-14	Sugar Pine Point	17.3	40	29	8	21	0	23	8
1-Jul-14	Sugar Pine Point	17.1	50	6	4	2	0	9	5
9-Aug-14	Sugar Pine Point	23.1	3	11	3	8	0	NA	NA
9-Aug-14	Sugar Pine Point	23.1	10	4	1	3	0	NA	NA
9-Aug-14	Sugar Pine Point	23.1	20	18	6	12	0	NA	NA
9-Aug-14	Sugar Pine Point	23.1	30	25	10	15	0	22	11
9-Aug-14	Sugar Pine Point	23.1	40	24	13	11	0	26	15
9-Aug-14	Sugar Pine Point	23.1	50	28	15	13	0	27	12
24-Sep-14	Sugar Pine Point	23.1	3	31	16	15	0	NA	NA
24-Sep-14	Sugar Pine Point	23.1	10	38	21	17	0	NA	NA
24-Sep-14	Sugar Pine Point	23.0	20	64	40	24	0	NA	NA
24-Sep-14	Sugar Pine Point	23.0	30	68	46	22	0	NA	NA
24-Sep-14	Sugar Pine Point	23.0	40	62	34	28	0	24	15
24-Sep-14	Sugar Pine Point	23.0	50	19	12	7	0	39	27
14-Oct-14	Sugar Pine Point	24.0	3	9	6	3	0	NA	NA
14-Oct-14	Sugar Pine Point	24.0	10	28	13	15	0	NA	NA
14-Oct-14	Sugar Pine Point	24.0	20	71	33	38	0	NA	NA
14-Oct-14	Sugar Pine Point	24.1	30	76	40	36	0	68	35
14-Oct-14	Sugar Pine Point	24.1	40	32	18	14	0	35	20
14-Oct-14	Sugar Pine Point	24.2	50	30	19	11	0	26	20

24-Feb-14	Sunnyside	20.7	3	0	0	0	0	NA	NA
24-Feb-14	Sunnyside	20.7	10	4	1	3	0	NA	NA
24-Feb-14	Sunnyside	20.7	20	6	3	3	0	7	3
24-Feb-14	Sunnyside	20.8	30	15	7	8	0	4	3
24-Feb-14	Sunnyside	20.8	40	15	5	10	0	1	1
24-Feb-14	Sunnyside	20.8	50	9	3	6	0	5	2
22-Apr-14	Sunnyside	23.1	3	0	0	0	0	NA	NA
22-Apr-14	Sunnyside	23.1	10	4	1	3	0	NA	NA
22-Apr-14	Sunnyside	23.2	20	7	3	4	0	6	4
22-Apr-14	Sunnyside	23.2	30	9	5	4	0	11	8
22-Apr-14	Sunnyside	23.3	40	6	4	2	0	7	5
22-Apr-14	Sunnyside	23.4	50	8	3	5	0	12	7
2-Jul-14	Sunnyside	21.5	3	9	3	6	0	NA	NA
2-Jul-14	Sunnyside	21.4	10	7	3	4	0	NA	NA
2-Jul-14	Sunnyside	21.3	20	41	27	14	0	NA	NA
2-Jul-14	Sunnyside	21.2	30	47	25	22	0	28	13
2-Jul-14	Sunnyside	21.1	40	30	14	16	0	34	22
2-Jul-14	Sunnyside	21.0	50	15	9	6	0	28	15
9-Aug-14	Sunnyside	24.0	3	11	6	5	0	NA	NA
9-Aug-14	Sunnyside	23.9	10	7	2	5	0	NA	NA
9-Aug-14	Sunnyside	23.9	20	3	2	1	0	NA	NA
9-Aug-14	Sunnyside	23.9	30	39	18	21	0	NA	NA
9-Aug-14	Sunnyside	23.9	40	48	23	25	0	31	19
9-Aug-14	Sunnyside	23.8	50	34	19	15	0	45	25
24-Sep-14	Sunnyside	22.6	3	20	15	5	0	NA	NA
24-Sep-14	Sunnyside	22.7	10	24	18	6	0	NA	NA
24-Sep-14	Sunnyside	22.8	20	31	18	13	0	NA	NA
24-Sep-14	Sunnyside	22.8	30	25	10	15	0	NA	NA
24-Sep-14	Sunnyside	22.9	40	37	23	14	0	NA	NA
24-Sep-14	Sunnyside	23.0	50	4	3	1	0	NA	NA
14-Oct-14	Sunnyside	22.3	3	5	1	4	0	NA	NA
14-Oct-14	Sunnyside	22.3	10	9	3	6	0	NA	NA
14-Oct-14	Sunnyside	22.4	20	18	5	13	0	NA	NA
14-Oct-14	Sunnyside	22.4	30	26	15	11	0	29	18
14-Oct-14	Sunnyside	22.4	40	14	8	6	0	30	20
14-Oct-14	Sunnyside	22.5	50	10	6	4	0	19	9
24-Feb-14	Tahoe City	19.6	3	2	1	1	0	NA	NA
24-Feb-14	Tahoe City	19.6	10	1	0	1	0	NA	NA
24-Feb-14	Tahoe City	19.6	20	18	10	8	0	9	6
24-Feb-14	Tahoe City	19.7	30	26	11	15	0	46	15
24-Feb-14	Tahoe City	20.0	40	31	11	20	0	39	10
24-Feb-14	Tahoe City	20.0	50	37	7	30	0	36	13
22-Apr-14	Tahoe City	22.8	3	1	0	1	0	NA	NA
22-Apr-14	Tahoe City	22.9	10	3	1	2	0	NA	NA
22-Apr-14	Tahoe City	23.0	20	7	4	3	0	NA	NA
22-Apr-14	Tahoe City	23.0	30	12	7	5	0	11	7
22-Apr-14	Tahoe City	23.1	40	18	11	7	0	24	14
22-Apr-14	Tahoe City	23.1	50	11	7	4	0	13	6
9-Aug-14	Tahoe City	24.0	3	52	23	29	0	NA	NA
9-Aug-14	Tahoe City	24.0	10	20	14	6	0	NA	NA
9-Aug-14	Tahoe City	23.9	20	14	6	8	0	NA	NA
9-Aug-14	Tahoe City	23.7	30	55	33	22	0	NA	NA
9-Aug-14	Tahoe City	23.6	40	22	16	6	0	NA	NA
9-Aug-14	Tahoe City	23.4	50	62	25	37	0	NA	NA
24-Sep-14	Tahoe City	23.0	3	18	10	8	0	NA	NA
24-Sep-14	Tahoe City	23.0	10	34	21	13	0	NA	NA
24-Sep-14	Tahoe City	23.0	20	87	47	40	0	NA	NA
24-Sep-14	Tahoe City	23.0	30	65	28	37	0	NA	NA
24-Sep-14	Tahoe City	23.0	40	45	27	18	0	NA	NA
24-Sep-14	Tahoe City	23.0	50	43	26	17	0	NA	NA
14-Oct-14	Tahoe City	23.0	3	21	9	12	0	NA	NA
14-Oct-14	Tahoe City	22.9	10	18	7	11	0	NA	NA
14-Oct-14	Tahoe City	22.7	20	68	28	40	0	NA	NA
14-Oct-14	Tahoe City	22.5	30	81	37	44	0	78	42

14-Oct-14	Tahoe City	22.4	40	60	28	32	0	71	38
14-Oct-14	Tahoe City	22.1	50	42	30	12	0	48	30