# Monitoring of Hospital Pond (2002):

## Willamette Basin Oregon Chub Investigations, Monitoring & Management


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## INTRODUCTION

The Oregon chub *Oregonichthys crameri* is endemic to the Willamette Valley of western Oregon. This species was formerly distributed throughout the Willamette Valley in off-channel habitats such as beaver ponds, oxbows, stable backwater sloughs, and flooded marshes, which are characterized by little to no water flow, silty and organic substrate, and abundant aquatic vegetation and cover for hiding and spawning. In the last 100 years, these habitats have disappeared rapidly because of changes in seasonal flows resulting from the construction of dams throughout the basin, channelization, revetments, diking, and drainage of wetlands. This loss of habitat, combined with the introduction of non-native species to the Willamette Valley, such as largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus,* have been implicated in the decline and the restricted distribution of Oregon chub. Oregon chub was listed as endangered in 1993 under the federal endangered species act (Rhew 1993).

ODFW's prior monitoring of the effects of water storage and flow management operations at Lookout Point Reservoir indicated that changes in reservoir elevation directly affected water levels, water temperatures, and the suitability and availability of Oregon chub habitat in Hospital Pond (Scheerer and McDonald 2000, 2001; Scheerer and Terwilliger 2002). Changes in reservoir and pond elevations have the potential to adversely affect Oregon chub, due to their effect on water temperatures and, consequently, reproductive behavior and success.

Due to drought conditions in the Willamette Valley in 2001, Lookout Point Reservoir did not fill (maximum elevation 877 feet). Consequently, conditions in Hospital Pond were different that in previous years (1998-2000) when life history investigations were conducted. Previous data suggested that filling of the reservoir was necessary for successful Oregon chub spawning in Hospital Pond. The drought conditions allowed us to directly test this hypothesis. We expanded our investigations in 2001 and 2002 to include determination of population age structure. These data were collected to assess the risk of potential recruitment failure to the chub population in single and successive years.

In 2002, the U.S. Army Corps of Engineers (Corps) repaired the gated water control structure that was installed in 2001 in the outflow culvert at Hospital Pond. The Corps also hired a contractor to dig a trench along the southwestern and western edges of the pond and apply bentonite clay in the trench and along the road fill in an attempt to seal water leaking around the culvert and through the road bed. Rainfall was normal in 2002 and sufficient to fill Lookout Point Reservoir. Reservoir elevation fluctuated between 916 and 922 feet between April 15 and July 22, 2002 (full pool = 926 feet).

The installation of the water control structure and the bentonite application were efforts to allow managers to artificially raise the water levels in Hospital Pond. These actions were somewhat effective at achieving that goal in 2002. The water level in the pond increased to an elevation of 926 feet, but subsequently dropped later in the summer when the reservoir level dropped, and stabilized at an elevation of ~920 feet, approximately two feet below the elevation of the vegetated terrace.

This report contains the results of research conducted in 2002 at Hospital Pond, including monitoring of air and water temperature profiles, monitoring of reservoir and pond level elevations, and collection and analysis of related Oregon chub biological data. These data will be useful to the U.S. Army Corps of Engineers for near-term and

long range water storage and flow management planning related to the protection of Oregon chub and their habitat in Hospital Pond.

## OBJECTIVES

Objective 1: Monitor temperatures and habitat conditions at Hospital Pond and relate these parameters to Lookout Point Reservoir elevation. Determine the effects of reservoir operations on Oregon chub spawning success.

Task 1.1: Monitor temperatures in Hospital Pond and air temperatures from May-September 2002.

Task 1.2: Monitor effects of reservoir elevation on quality and quantity of available spawning habitat in Hospital Pond from May-September 2002.

Task 1.3: Monitor spawning success of Oregon chub by determining approximate hatch dates from a sample of 50 juvenile Oregon chub captured in the fall of 2002. Relate hatch date distribution to pond temperatures and habitat conditions. Compare results from 2002 with hatch date distributions for 1998, 2000, and 2001.

Task 1.4: Determine the effect (risk) of year-class failure resulting from drought conditions in 2001 (Lookout Point Reservoir did not fill in 2001 with possible effects on Oregon chub recruitment). Determine the population age structure from a random sample of 50 adult chub using otolith aging techniques and compare the results to those from a similar sample collected in 2001.

Objective 2: Monitor natural and introduced populations of Oregon chub on U.S. Army Corps of Engineers' properties. Evaluate potential reintroduction sites. Provide management recommendations, as needed.

Task 2.1: Obtain population estimates for naturally occurring Oregon chub populations in Hospital Pond and Dexter Reservoir alcoves in 2002. Provide assistance in researching management options for Dexter Reservoir alcoves.

Task 2.2: Monitor reintroductions of Oregon chub at Fall Creek Spillway Ponds, Foster Pullout Pond, and Menear's Bend in 2002.

Task 2.3: Evaluate potential reintroduction sites on Corps' properties.

**Background Data Regarding Hospital Pond and Oregon Chub**

Hospital Pond is a long (~300 meters), narrow (~6-10 meters), deep (2.0-4.0 meters), spring-fed pond that was created during the construction of the North Shore Road near Lookout Point Reservoir. A culvert connects the pond to Lookout Point reservoir at reservoir elevations exceeding 917 feet (full pool elevation is 926 feet). Temperature studies conducted in 1997-2001 revealed that pond temperatures remain relatively constant and cold (8-12$^0$C) during most of the year and increase in the summer (June-July). As the reservoir fills, the pond elevation increases (up to ~2.5 meter increase). When the pond elevation increases, the surface area also increases (width increases to ~20 meters) when a shallow, vegetated pond terrace is flooded. The pond temperature increases due to the effects of solar radiation heating water on the shallow vegetated terrace (elevation ~922 feet). Temperatures suitable for Oregon chub spawning (>16$^0$C) only occur when the reservoir is full (June to mid-July) and occur primarily on the terrace. Pond temperatures in the main body of the pond remain cold (10-12$^0$C) throughout the summer due to the high influx of cold spring water.

Pond temperatures can affect Oregon chub spawning success. From field observations, we found that Oregon chub in Hospital Pond spawn from late-May through early-July when pond temperatures exceed 16$^0$C. From laboratory spawning experiments, we found that no spawning occurred (no noticeable gonadal development) when chub were reared under a natural photoperiod regime at constant temperatures of 12-13$^o$C. Spawning was observed when chub were reared under natural photoperiod regimes at constant temperatures of 16-17$^0$C and 20-21$^0$C.

Otolith analyses were conducted in Hospital Pond in 1998 and 2000 to determine the approximate timing of Oregon chub spawning (hatch date distributions) in relation to pond temperatures. Hatch date analyses found that hatching occurred from the end of May through early-July and peaked during June. Juvenile survival was highest for fish hatched between mid-June and early-July (spawning occurs ~7 days prior to hatching). Spawning occurred when the pond temperatures exceeded 16$^0$C. No juveniles were collected which had hatch dates after early-July, which coincided with the lowering of reservoir levels below 922 feet, and the exposure of the shallow terrace. In 2001, drought conditions existed in the Willamette Valley and Lookout Point Reservoir only filled to 877 feet in elevation. Very few juveniles were found in the pond in 2001, suggesting minimal reproductive success.

Otolith aging (non-random sample) was conducted in 1997-1998 to determine age composition (Scheerer and McDonald 2000). We found fish aged 0-5 years, with the majority of the fish less than 4 years old. We also noted that no fish from the 1992 and 1994 brood years were present. These were years when the reservoir did not fill, suggesting possible recruitment failure in those years. A random aging sample was collected and aged in 2001. Chub ranged in age from 0-7 years, with the majority being less than 4 years old. The relatively broad age structure suggests that the population may be buffered from the effects of recruitment failure in a single year.

ODFW has monitored the Oregon chub population in Hospital Pond since 1993. Population abundance was lowest in 1993 (n=690; 95% CI= 470-1,300) and 1995 (n=780; 95% CI= 510-1,390). The reservoir did not fill in 1992 or 1994 and presumably recruitment was minimal. Population abundance was relatively high and stable between 1997-2000: 1997 (n=3,160; 95% CI= 2,480-4,370), 1998 (n=3,030; 95% CI= 2,050-5,780), 1999 (n=3,020; 95% CI= 2,330-4,290), 2000 (n=2,980; 95% CI= 2,050-

5,410). Population abundance declined in both 2001 (n=2,700; 95% CI= 1,830-5,140) and 2002 (n=2,130; 95% CI= 1,680-2,910).

These data suggest that successful spawning and recruitment in Hospital Pond is dependent upon Lookout Point Reservoir being full in June and early-July. In an attempt to artificially control water levels and water temperatures in Hospital Pond, the Corps installed a gate on the culvert exiting Hospital Pond in the spring of 2001. However, leakage around the culvert prevented pond elevations from increasing more than ~1 foot in 2001. In the spring of 2002, the Corps sealed the west end of the pond with bentonite clay and replaced the gate on the culvert in a second effort to seal the pond and to allow biologists to regulate Hospital Pond elevation independently of the elevation of Lookout Point Reservoir.

## MATERIALS & METHODS

### *Temperature Monitoring*

Temperature recorders (Hobo®) were placed at four locations in and around Hospital Pond. Three recorders were placed in Hospital Pond. One recorder was placed on the bottom of the pond, near the culvert at the southwestern end of the pond, a second recorder was attached to a cable that was anchored to a post and was floated in the pond approximately 0.1 meters below the surface near the center of the pond, and a third recorder was placed on the shallow vegetated terrace on the south side of the pond. This recorder was only submerged when the reservoir elevation exceeded ~922 feet. Air temperature was monitored with a recorder placed on the branch of a tree (approximately 2 meters above the ground) growing on the edge of the shallow vegetated terrace of the pond. This recorder was covered with moss and remained in the shade throughout the day. Recorders were set to record at five hour intervals. The maximum temperature recorded each day was used to determine whether the threshold temperature of approximately 16$^{o}$C necessary for Oregon chub to spawn was exceeded (Scheerer and McDonald 2000).

### *Adult Aging*

In May 2002, we collected a random sample of 50 adult Oregon chub from Hospital Pond using baited minnow traps. The fish were collected to determine the age structure of the population. The fish were sacrificed and placed in 95% ethanol. Samples were taken back to the lab to be processed. Total lengths were measured to the nearest millimeter. The right lapillus was removed from all Oregon chub using a fine tip probe under a dissecting scope. Each otolith was soaked in a 10% bleach solution for several minutes to remove tissue, rinsed twice with distilled water, rinsed a third time with 95% ethanol, and allowed to air dry (Secor et al. 1992). Otoliths were embedded into molds (plugs) of Spurr® epoxide resin (Spurr 1969). Plugs were mounted on glass slides for thin sectioning using a low speed Isomet® diamond blade saw. Two transverse cuts were made into the plug to produce a thin section (0.5mm) that included the otolith core. Thin sections were mounted on glass slides in Crystal Bond, ground using 1500 grit wet/dry sandpaper, and polished using Buehler Gamma Micropolish alumina solution (0.05 micron) and Buehler Microcloth polishing cloth. Adult otoliths were aged using transmitted light at 250X under a compound scope.

Adult otoliths were read twice by one reader. If there was a discrepancy, a third reading was made. In these cases, the age determined in the majority of reads was assigned to the otolith.

*Hatch Date Distribution*

In late-September 2002, we collected 50 juvenile Oregon chub from Hospital Pond to determine their hatch date distribution and to relate the onset and duration of spawning with pond temperatures. Otoliths (right lapilli) were removed using a fine tip probe under a dissecting scope. Otoliths were mounted dorsoventrally in Crystal Bond® on glass slides and polished in the sagittal plane to the core. Otoliths were flipped and polished on both sides to improve resolution of growth increments. Otoliths were ground using 1500 grit wet/dry sandpaper and polished using Buehler® Gamma Micropolish alumina solution (0.05 micron) and Buehler Microcloth polishing cloth. Otoliths were aged with transmitted light at 500X using a microcomputer equipped with Optimas® imaging software. Each translucent-opaque band represented a daily growth increment (DGI) (Campana and Neilson 1985). DGI were counted from the core out to, and including, the posterior edge of the otolith. Increments that disappeared when adjusting the fine focus were not counted as DGI. Hatch dates were estimated by subtracting the number of daily increments from the collection date. Spawning dates were estimated to be seven days prior to the hatch date. Since data for incubation time was not available for Oregon chub, we used available data, approximately 7 days from spawning to hatching, for redside shiner *Richardsonius balteatus* (Weisel and Newman 1951). Otoliths from juvenile fish were read three times by one reader. A final age was assigned that was the median of the three counts. Hatch dates were combined into one-week (7 day) categories.

*Population Estimates*

Population estimates were obtained for naturally occurring Oregon chub populations at Hospital Pond and the Dexter Reservoir alcoves and for introduced Oregon chub populations in the Fall Creek Spillway Ponds, Foster Pullout Pond, and Menear's Bend. Minnow traps (23cm x 46cm with 64mm mesh) were used to capture chub. Traps were baited with a half slice of bread and set for 3-18 hours. We marked fish with a partial caudal fin clip and returned them to the water. Population size was estimated using single-sample mark-recapture procedures (Ricker 1975). Confidence intervals were calculated using a Poisson approximation (Ricker 1975). Fish smaller than ~35 millimeters in length were not captured by the minnow traps, and were not included in the estimates. Excluded from estimates were all age 0+ fish (Scheerer and McDonald 2000).

## RESULTS

*Temperature Monitoring*

Temperatures in Hospital Pond varied substantially depending on the location of the temperature monitor (Figure 1). From May 1 through July 20, 2002, changes in water temperature measured on the vegetated terrace (mean 15.9 $^{o}$C; range 10.6-19.4 $^{o}$C) closely paralleled changes in air temperature (mean 20.6 $^{o}$C; range 11.1-26.1 $^{o}$C).

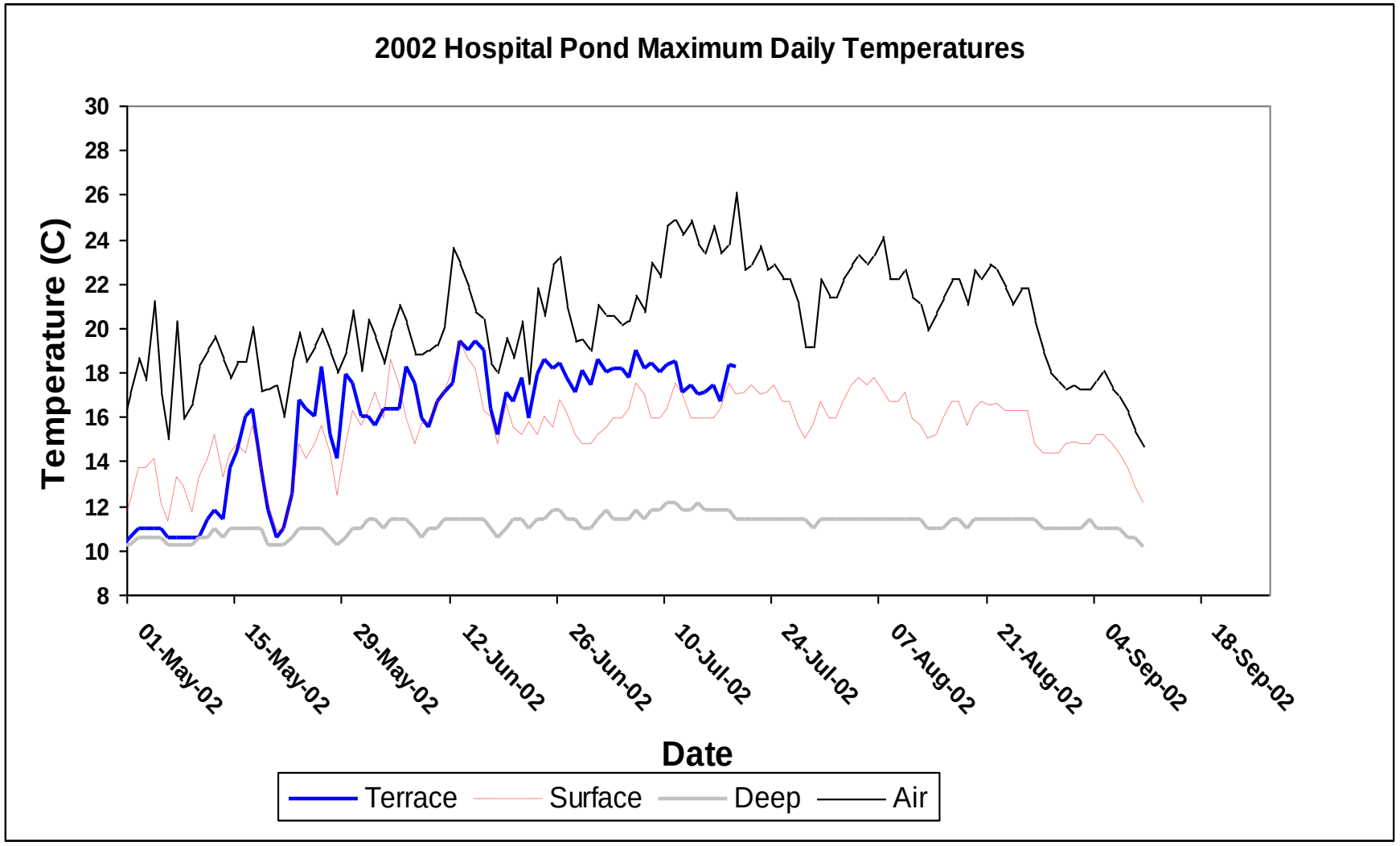


Figure 1. Temperatures recorded at Hospital Pond between May 1 and September 10, 2002.

Water temperatures were substantially cooler on the bottom of the pond (mean 11.2 °C; range 10.2-12.2 °C). The cold, dense spring water that enters the pond at the eastern end sinks to the bottom, flows through the pond, and exits out of the culvert at the southwestern end. The warmer surface strata (mean 15.6 °C; range 10.9-19.4 °C) covers this cold strata and extends ~0.15 meters down from the surface. There is very little pond edge habitat exposed to these warmer surface temperatures when the reservoir elevation is less than 917 feet.

*Adult Aging*

Ages of adult Oregon chub in Hospital Pond ranged from 2-6 years (Figure 2; Table 1). The fish collected for aging ranged in size from 44-82mm (total length). No age 1 fish were present in the sample, evidence of recruitment failure during the drought conditions that occurred in 2001.

*Hatch Date Distribution*

Approximate hatch dates for the juvenile chub (14-35mm) collected in 2002 extended from June 19 through July 28 and peaked in mid-July (Figure 3). Pond temperatures measured on the vegetated terrace when these fish were spawned averaged 18 °C (range 15-19 °C). The 2002 hatch date distribution extended two weeks later than the distributions from 1998 and 2000, presumably because we were able to artificially maintain elevated pond levels later into July than would normally occur (Figure 4). The hatch date distribution for fish collected in 1998 extended from mid-June through mid-July and peaked near the end of June. Pond temperatures ranged from 16-17 °C during this period. The hatch date distribution for fish collected in 2000 was similar to the 1998 distribution, extending from late-May through mid-July and peaking near the end of June (Figure 3). Pond temperatures ranged from 16-20 °C during this period. The 1998 and 2000 hatch date distributions were not significantly different ($p>0.10$), yet both were significantly different from the 2002 hatch date distribution ($p<0.05$).

In 1998, spawning was noted as early as mid-May, determined from otolith aging of a sample of juveniles collected in mid-July, although no fish that hatched prior to mid-June were found in the October collection (Scheerer and McDonald 2000). Similarly, we found low survival of early hatched Oregon chub in East Fork Minnow Creek Pond in both 1997 and 1998 (Scheerer and McDonald 2000). These data suggest that Oregon chub hatched prior to mid-June have poor survival rates and may not contribute substantially to the adult population.

*Population Estimates*

Currently, there are six populations of Oregon chub located in habitats on U.S. Army Corps of Engineers properties. Naturally occurring populations are found at Hospital Pond and in two Dexter Reservoir alcoves, located in the Middle Fork Willamette River drainage. Introduced populations are found in the Fall Creek Spillway Ponds in the Middle Fork Willamette drainage, and in Foster Pullout Pond and Menear's Bend in the Santiam drainage. The 2002 population abundance estimates for these locations are presented in Table 2. Also included in Table 2 are estimates for prior years at these locations.

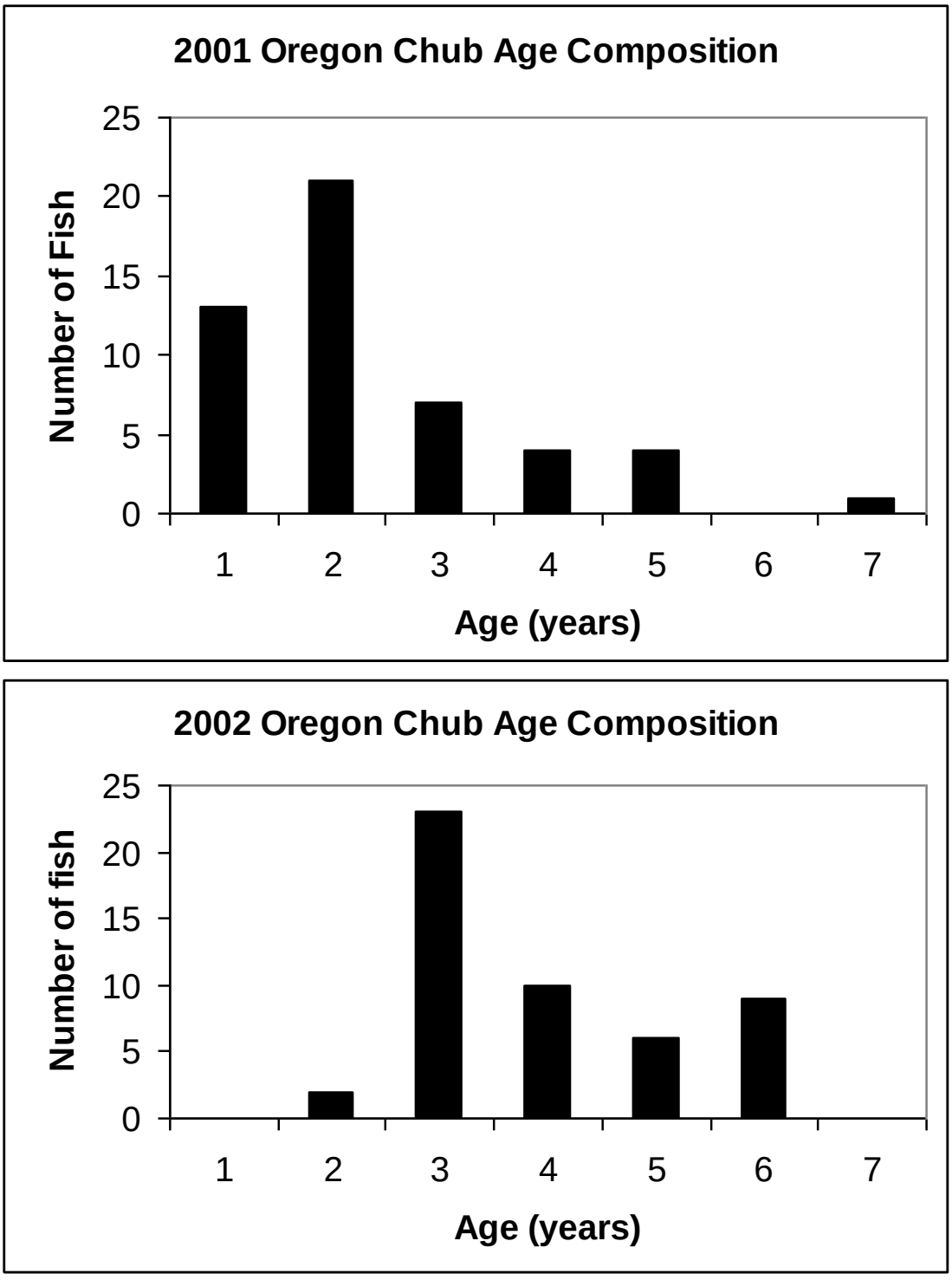


Figure 2. Age structure of the Oregon chub population in Hospital Pond in 2001 and 2002.

Table 1. Mean lengths at capture and 95% confidence intervals for Oregon chub in Hospital Pond in 2001 and 2002.

| | Age (years) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **2001** | | | | | | | |
| Mean total length (mm) | 55.3 | 63.4 | 65.3 | 72.0 | 72.5 | - | 85.0 |
| 95% confidence interval | (53.8 - 56.8) | (62.1 - 64.7) | (62.5 - 69.1) | 69.7 - 74.3) | (63.6 - 81.4) | - | - |
| Number of fish | 13 | 21 | 7 | 4 | 4 | 0 | 1 |
| Percentage of sample | 26 | 42 | 14 | 8 | 8 | 0 | 2 |
| **2002** | | | | | | | |
| Mean total length (mm) | - | 57.0 | 67.1 | 68.8 | 72.8 | 77.1 | - |
| 95% confidence interval | - | (31.6 - 82.4) | (65.2 - 69.0) | (66.5 - 71.1) | (65.0 - 78.6) | (74.3 - 79.9) | - |
| Number of fish | 0 | 2 | 23 | 10 | 6 | 9 | 0 |
| Percentage of sample | 0 | 4 | 46 | 20 | 12 | 18 | 0 |

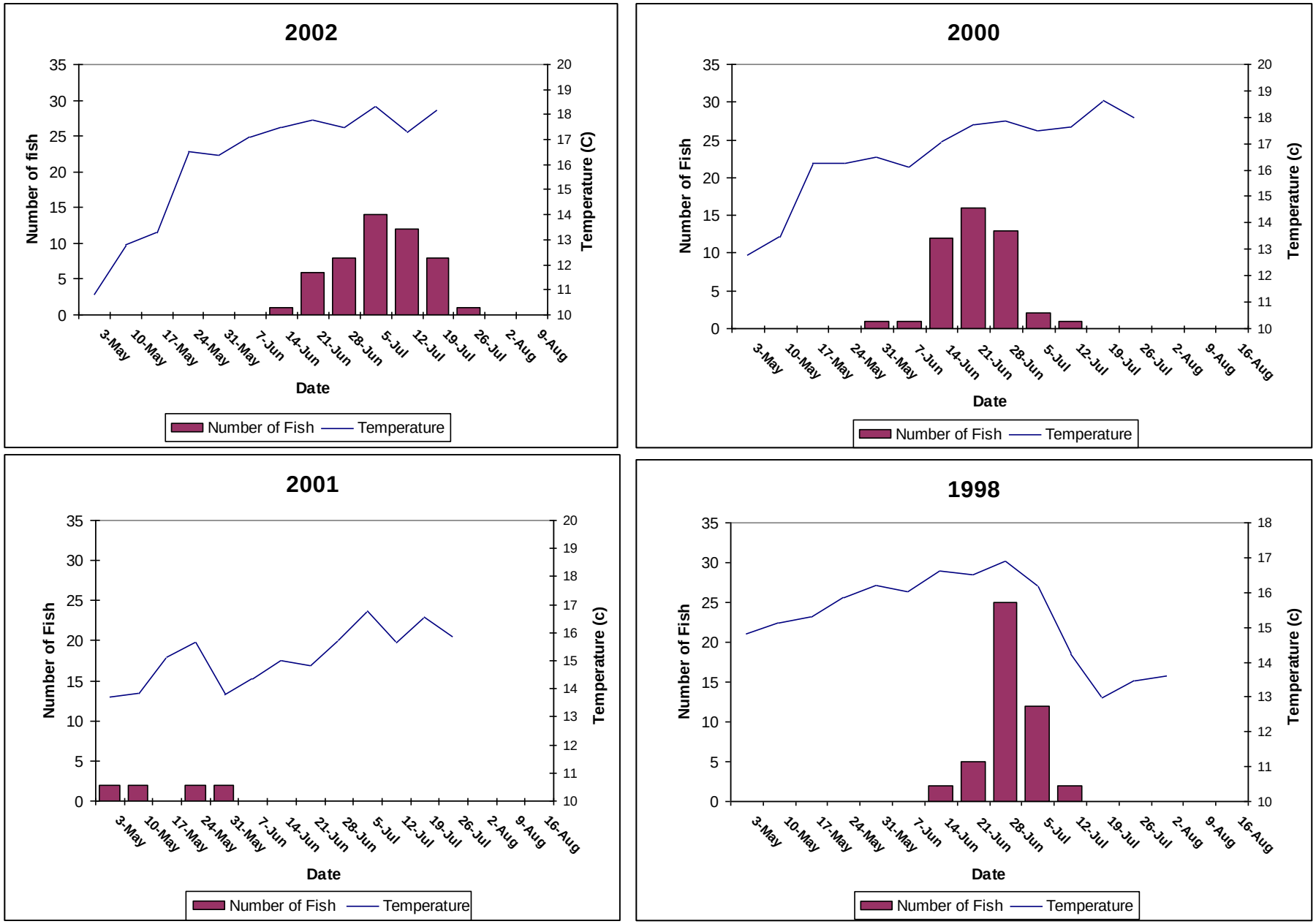


Figure 3. Oregon chub hatch date distributions and mean weekly temperatures in Hospital Pond in 1998, 2000, 2001, and 2002.

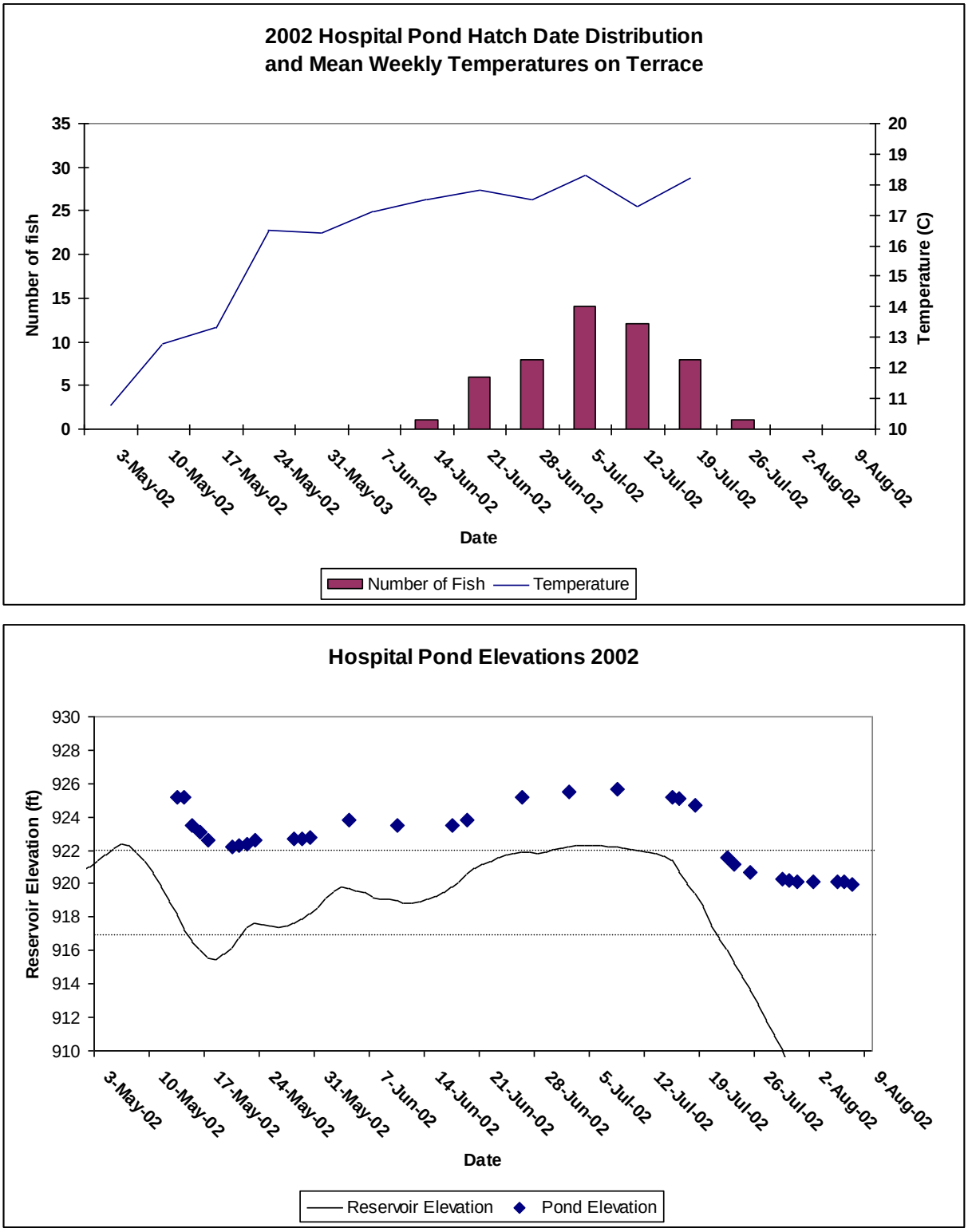


Figure 4. Oregon chub hatch date distribution, average weekly temperatures on the pond terrace, and water elevations at Hospital Pond and Lookout Point Reservoir in 2002. Dotted horizontal lines represent the Hospital Pond culvert elevation (917 ft) and terrace elevation (922 feet).

Table 2. Estimates of the population abundance of Oregon chub at locations on U.S. Army Corps properties in the Willamette Valley, Oregon from 1992-2002.

| Location | Date | Estimate | 95% Confidence Limits lower | upper |
|---|---|---|---|---|
| Foster Pullout Pond[1] | October 2000 | 80 | 40 | 320 |
| | May 2001 | 210 | 130 | 700 |
| | May 2002 | 320 | 200 | 780 |
| Menear's Bend[1] | May 2001 | 7 | | |
| | May 2002 | 29 | 16 | 110 |
| Dexter Reservoir Alcove (RV Park) | September 1997 | 1,330 | 990 | 2,060 |
| | September 1998 | 830 | 590 | 1,410 |
| | September 1999 | 50 | 20 | 100 |
| | September 2000 | 880 | 580 | 1,770 |
| | September 2001 | 1,950 | 1,690 | 2,310 |
| | September 2002 | 2,270 | 1,840 | 2,980 |
| Dexter Reservoir Alcove (The Pit) | May 1992 | 780 | 560 | 1,100 |
| | May 1995 | 140 | 80 | 400 |
| | September 1996 | 40 | 20 | 200 |
| | September 1997 | 920 | 760 | 1,170 |
| | September 1998 | 450 | 380 | 540 |
| | September 1999 | 1,130 | 910 | 1,480 |
| | September 2000 | 1,440 | 1,030 | 2,440 |
| | September 2001 | 800 | 600 | 1,200 |
| | September 2002 | 460 | 280 | 1,330 |

Table 2. (continued).

| Location | Date | Estimate | 95% Confidence Limits lower | upper |
|---|---|---|---|---|
| Hospital Pond | May 1993 | 690 | 470 | 1,300 |
| | May 1995 | 780 | 510 | 1,390 |
| | May 1997 | 3,160 | 2,480 | 4,370 |
| | May 1998 | 3,030 | 2,050 | 5,780 |
| | May 1999 | 3,020 | 2,330 | 4,290 |
| | May 2000 | 2,980 | 2,050 | 5,410 |
| | May 2001 | 2,700 | 1,830 | 5,140 |
| | May 2002 | 2,130 | 1,680 | 2,910 |
| Fall Creek Spillway Ponds[1] | September 1997 | 480 | 400 | 590 |
| | September 1998 | 1,400 | 960 | 2,660 |
| | September 1999 | 6,300 | 5,460 | 7,450 |
| | September 2000 | 5,030 | 4,060 | 6,620 |
| | September 2001 | 7,770 | 6,480 | 9,690 |
| | September 2002 | 6,370 | 5,320 | 7,930 |

[1] Introduced populations of Oregon chub.

The 2002 population estimate for Hospital Pond was 2,130 adult chub (95% CI: 1,680-2,910). This was a 21% decline in population abundance compared to the 2001 estimate (n=2,700) and less than estimates for this location in 1997-2000 (2,980-3,160).

The 2002 estimate for the Dexter Reservoir alcove "The Pit" was 460 adult chub (95% CI: 280-1,330). This population has fluctuated substantially since 1992 and declined steadily since 1999. The 2001 estimate for the western alcove of Dexter Reservoir near the RV park was 2,270 adult chub (95% CI: 1,840-2,980). This population has increased steadily since 1999. Nonnative fish have access to the Dexter Reservoir alcoves from Dexter Reservoir and have been collected from these locations in the past. ODFW and the Corps have discussed options to protect Oregon chub populations by restricting movement of non-native fish from Dexter Reservoir into the alcoves.

In 1996, Oregon chub were introduced into the Fall Creek Spillway Ponds, located in the overflow channel below Fall Creek Dam. The ponds were formed by beaver dams that blocked the spillway overflow channel. These dams have been in existence for approximately 15 years. A total of 500 Oregon chub were moved from Shady Dell Pond (n=150) and East Fork Minnow Creek Pond (n=350) to these ponds in 1996. The population abundance increased rapidly. In 2002, the chub population totaled 6,370 adults (95% CI: 5,320-7,930) and was the second largest chub population in the Willamette Valley (Scheerer et al. 2003).

Foster Pullout Pond is located on the north shore of Foster Reservoir in the South Santiam River drainage. The isolate beaver pond is perched several meters above the reservoir full pool level and is spring-fed. Oregon chub were introduced into this pond from Geren Island in the North Santiam drainage. Fish were transferred in 1999 (n=85), 2000 (n=20), 2001 (n=75), and 2002 (n=50). In 2002, the chub population estimate was 320 fish (95% CI: 200-780).

Menear's Bend Pond is located in the Middle Santiam drainage upstream of Foster Reservoir. The pond is a small beaver pond that is fed by a small tributary and springs. Oregon chub were introduced from Geren Island in 2000 (n=15) and 2002 (n=26). The 2002 population estimate was 29 fish (95% CI: 16-110).

Hospital Impoundment Pond is a habitat enhancement project which is located in Lookout Point Reservoir (Middle Fork Willamette drainage) adjacent to Hospital Pond. It was constructed by the U.S. Forest Service and the U.S. Army Corps of Engineers in 1994. This pond was excavated in a former railroad grade in the drawdown zone of the reservoir. The outflow from Hospital Pond was diverted into the pond. The fish community in this pond varies each year, depending on which species enter the pond from Lookout Point Reservoir or Hospital Pond. Non-native fish, which originate from the reservoir, were collected in 1995, 1997, 1998, 1999, 2000, 2001, and 2002. Only a few Oregon chub were collected in 1995 (n=6), 1997 (n=1), and 1999 (n=1) (Scheerer et al. 2003). The pond appears to provide few benefits for Oregon chub.

## DISCUSSION & RECOMMENDATIONS

### Hospital Pond

Previous investigations at Hospital Pond established links between water elevations of Lookout Point Reservoir, water levels and water temperatures in Hospital Pond, and Oregon chub spawning and recruitment in Hospital Pond (Scheerer and McDonald 2001, Scheerer and Terwilliger 2002).

We found that water temperatures in Hospital Pond varied substantially depending on the location of the temperature monitor. Pond temperatures measured on the vegetated terrace were often the warmest water temperatures recorded, and typically exceeded 16°C during Oregon chub spawning season in June and July (Scheerer and McDonald 2001, this study). The water temperatures recorded on the pond terrace closely paralleled changes in air temperatures (Scheerer and McDonald 2001, this study), and were independent of reservoir temperatures (Scheerer and McDonald 2001). Pond temperatures were consistently much cooler in the main body of the pond than on the terrace and the pond surface. The pond is fed by cold spring water that enters the eastern end of the pond and exits through the culvert at the western end.

Prior to recent modifications, pond elevation was determined by Lookout Point Reservoir elevation. When the reservoir elevation exceeded 917 feet, Hospital Pond was connected to the reservoir. This occurred between May 2 and July 17 in 1998 (77 days) and between May 9 and July 26 in 2000 (79 days). When the reservoir elevation exceeded 922 feet, the vegetated terrace was flooded. The water on the shallow vegetated terrace is exposed to solar radiation and warm air and the water temperature increased. This occurred between May 7 and July 9 in 1998 (74 days) and between May 12 and July 19 in 2000 (69 days). Due to drought conditions in 2001, Lookout Point Reservoir elevation reached a maximum elevation of only 876 feet (on May 9, 2001) and the vegetated terrace in Hospital Pond was never covered with water.

The availability of suitable spawning habitat in Hospital pond is largely dependent on the flooding of the vegetated terrace. The majority of the aquatic vegetation in Hospital Pond (the surface upon which chub lay their adhesive eggs) and the warmest temperatures are both found on the terrace. The total vegetated area of the pond increases from ~800 $m^2$ to ~1,800 $m^2$ when the terrace is flooded. We found that successful spawning of Oregon chub in 1998-2000 occurred only when the reservoir elevation exceeded 922 feet and the vegetated terrace was flooded (June through mid-July). When the reservoir dropped in mid-late July, the water temperature in the pond dropped, and successful spawning ceased.

Drought conditions in the Willamette River basin in 2001 negatively impacted the recruitment of Oregon chub in Hospital Pond. Successful spawning was limited in 2001. Very low numbers of juvenile chub were observed and collected in the fall sampling in 2001 and age 1 fish were absent from the 2002 aging sample. Presumably this caused the ~20 percent decline in Oregon chub population abundance from 2,700 adult chub in 2001 to 2,130 chub in 2002.

Attempts to regulate pond elevations independently of Lookout Point Reservoir elevations were made in 2001 and 2002. In the spring of 2001, the Corps installed a gate on the culvert exiting Hospital Pond. However, leakage around the culvert and through the road fill prevented pond elevations from increasing more than ~1 foot in 2001 (maximum elevation ~918 feet). In the spring of 2002, the Corps sealed the western end of the pond with bentonite clay and reconstructed/replaced the gate on the

culvert in a second attempt to seal the pond. Results were more promising in 2002, but not entirely successful. We were able to maintain pond elevations between 920 and 926 feet, but pond elevation was not entirely independent of reservoir elevation. Pond elevation was maintained above 922 feet, the elevation of the vegetated terrace, from April 17 through July 20, 2002 (65 days), but dropped below 922 feet when the reservoir elevation dropped below ~916 feet. The pond elevation stabilized at ~920 feet as reservoir levels decreased from 907 feet to 869 feet during August 2002. Fortunately, precipitation was normal in 2002 and the Corps was able to maintain the elevation of Lookout Point Reservoir above ~916 feet between April 17 and July 20 (65 days) to allow Oregon chub to spawn. Oregon chub spawning appeared to be quite successful in 2002; juvenile chub were very abundant. Unfortunately, because the pond levels are still tied to reservoir levels, the Corps currently does not have full availability (use) of water stored in Lookout Point Reservoir for flow augmentation prior to mid-July

To assess the risk of recruitment failure on the Hospital Pond chub population in single and successive years, we collected aging data in 2001 and 2002. Several age classes were represented in the Hospital Pond population in both years, which suggests that the population age structure is broad enough for the population to withstand the effects of recruitment failure without the population abundance falling below levels where a genetic bottleneck might occur (~500 fish). For example, despite the presence of very few age 1 or age 2 Oregon chub in 2002, the population abundance was still relatively high (n=2,130). We calculated the effect of recruitment failure on total egg production for the population. If successive year-classes (ages 1-3) were absent from the 2002 population, the total egg production for the population would have been reduced by only 40-49 percent (**APPENDIX A**).

To minimize potential adverse impacts to Oregon chub, we recommend that the Corps either attempt to maintain Lookout Point Reservoir levels above ~916 feet from mid-May through mid-July of each year or to create spawning habitat in Hospital Pond by excavating areas of the terrace that could be flooded by closing the gate on the culvert. This would allow the Corps to both provide spawning habitat for chub in Hospital Pond and increase options for using Lookout Point Reservoir storage for flow augmentation for listed anadromous salmonids.

**Dexter Reservoir Alcoves**

Management options that have been discussed to protect populations of Oregon chub in the Dexter Reservoir alcoves (The Pit and the western alcove near the RV park) include the installation of water control structures or screens to prevent movement of nonnative fish from Dexter Reservoir into the alcoves. Past ODFW surveys indicate that years when nonnative fish were collected in the alcoves, chub populations declined substantially. Water control structures could also be designed to maintain minimum water levels in the alcoves and to minimize daily fluctuations in pond levels that result from reservoir operation. Dexter Reservoir is operated with daily water level fluctuations of up to 5 feet (1.5 meters). Minimizing daily fluctuations, especially during the chub spawning season, may improve recruitment by reducing mortality of eggs spawned on vegetation that might be exposed to the air (desiccate) when reservoir levels drop.

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**APPENDIX A**. Fecundity estimates calculated for different age-classes of Oregon chub in Hospital Pond in 2002. Fecundity was estimated using the exponential regression model from Pearsons (1989), where fecundity = $e^{(2.7 + 0.06 \times \text{total length})}$. The regression was for fish ranging in size from 41-64mm total length (TL). Table A extrapolates fecundity beyond the original data used to develop the regression. Table B uses a calculated fecundity for a 64mm fish (n=692 eggs) for all fish >64 mm TL. Abundance of females was assumed to be half the total adult abundance, assuming a 1:1 female to male sex ratio.

**A.**

| Age (yr) | 2002 Chub abundance | Mean length (mm) | Calculated fecundity | Sum of fecundity for the age-class | Percent of summed fecundity for all age-classes |
|---|---|---|---|---|---|
| 1 | 0 | | | | 0.0 |
| 2 | 42 | 57.0 | 455 | 19,104 | 1.8 |
| 3 | 490 | 67.1 | 834 | 408,565 | 38.3 |
| 4 | 213 | 68.8 | 923 | 196,672 | 18.4 |
| 5 | 128 | 72.8 | 1,174 | 150,246 | 14.1 |
| 6 | 192 | 77.1 | 1,519 | 291,704 | 27.4 |
| Total | 1,065 | | | 1,066,291 | 100.0 |

**B.**

| Age (yr) | 2002 Chub abundance | Mean length (mm) | Calculated fecundity | Sum of fecundity for the age-class | Percent of summed fecundity for all age-classes |
|---|---|---|---|---|---|
| 1 | 0 | | | | 0.0 |
| 2 | 42 | 57.0 | 455 | 19,104 | 2.6 |
| 3 | 490 | 67.1 | 692 | 339,080 | 46.6 |
| 4 | 213 | 68.8 | 692 | 147,396 | 20.3 |
| 5 | 128 | 72.8 | 692 | 88,576 | 12.2 |
| 6 | 192 | 77.1 | 692 | 132,864 | 18.3 |
| Total | 1,065 | | | 727,020 | 100.0 |