San Joaquin River Restoration Program spring-run Chinook Technical Memorandum
Mass Marking - Annotated Bibliography
NMFS 7/3/2014

Bangs B.L., M.R. Falcy, P.D. Scheerer, and S. Clements. 2013. Comparison of three methods for marking a small floodplain minnow. Animal Biotelemetry 1:18.

http://www.animalbiotelemetry.com/content/1/1/18

Several techniques were evaluated for marking 40-70 mm long Oregon chub. The marking techniques were two different sizes of PIT tags (9 x 2.12 mm [PIT-tag] and 8.4 x 1.4 mm [PICO-tag]), visible implant elastomer (VIE) tags, and freeze branding. Marking using freeze branding, VIE tags, and PICO-tags had no effect on survival while fish marked with PIT-tags had significantly lower survival than those in the control group. In addition, survival was significantly higher for fish marked with the PICO-tag than with the PIT-tag. Tag retention was 94% for PIT-tags and 95% for PICO-tags. The mark on 80% of freeze branded fish and 88% of VIE marked fish was easily discernible after 150 days, respectively.

Buttars, B. 2014. Central Valley salmon and steelhead marking/coded-wire tagging program: 2013 marking season. Pacific States Marine Fisheries Commission, Portland, Oregon.

http://www.fws.gov/sacramento/fisheries/CAMP-Program/Documents-Reports/Documents/2013_Constant_Fractional_Marking_Report.pdf

For each production release of fall-run Chinook salmon from Central Valley hatcheries, 25% of the fish were targeted to be marked with a coded-wire tag and an adipose fin-clip. The spring-run Chinook salmon raised at the Feather River Fish Hatchery were 100% marked with a coded-wire tag and an adipose fin-clip. Tagging trailers were used to perform all of the coded-wire tagging and adipose fin-clipping. The tagging trailers were also used to adipose fin-clip 100% of the steelhead reared at Coleman National Fish Hatchery, Feather River Fish Hatchery, and Nimbus Fish Hatchery.

Cousin, X., T. Daouk, S. Pean, L. Lyphout, M-E. Schwartz, and M-L. Begout. 2012. Electronic individual identification of zebrafish using radion frequency (RFID) microtags. The Journal of Experimental Biology 215: 2729-2734.

RFID microtags (6 x 1 mm) were used to tag juvenile zebrafish (16-42 mm length) and then fish survival, tag loss, growth, spawning, and exploratory behavior were studied. There was high survival (82%) and low tag loss (11%) after 5.5 months. No negative effects on growth were observed and some of the tagged fish spawned. There were no significant differences in behavioral responses between tagged and un-tagged fish. The results suggest that RFID microtags are suitable for tagging fish as small as 16-42 mm.

Elle, F.S., M.K. Koenig, and K.A. Meyer. 2010. Evaluation of calcein as a mass mark for rainbow trout raised an outdoor hatchery raceways. North American Journal of Fisheries Management 30: 1408-1412.

Calcein mark retention was evaluated in rainbow trout using external (head, fins) and internal (otoliths) marks. Mark retention was also compared between fish reared in outdoor raceways and those reared indoors in circular tanks. Rainbow trout fry reared in the outdoor raceways that were marked had significant mark deterioration within 8 day post-marking and remained poor through the rest of the study. Fish reared indoors had better mark retention but there was still degradation over the 7 months of the study. Otoliths marked with calcein were visible for the entire study period for rainbow trout reared both indoors and outdoors. Sunlight appears to cause degradation to fish marked externally with calcein. Otolith calcein marks performed well but required lethal sampling with a long processing time.

Evenson, M.H. and R.D. Ewing. 1985. Long-term retention of fluorescent pigment marks by spring Chinook salmon and summer steelhead. North American Journal of Fisheries Management 5: 26-32.

Juvenile spring Chinook salmon and summer steelhead reared at Cole Rivers Hatchery (Rogue River, OR) were marked using fluorescent granular polystyrene pigment. Marked fish also received one or more fin or maxillary clips to identify them as having been fluorescent marked. Returning adults to the hatchery were then checked for marks. Spring Chinook salmon retained the marks for up to 54 months in sixty percent of fish and 67% of summer steelhead retained the marks for 56 months.

Everest, F.H. and E.H. Edmundson. 1967. Cold branding for field use in marking juvenile salmonids. The Progressive Fish-Culturist 29(3): 175-176.

Cold branding was used to mark juvenile Chinook salmon and steelhead in the field. The branding tools were cooled in a mixture of dry ice and acetone. The mark becomes visible in 2 to 3 days after brand tool is held against fish for 3 seconds. The brand mark is readable for 5 to 6 weeks.

Gaines, P.C. and C.D. Martin. 2004. Feasibility of dual-marking age-0 Chinook salmon for mark-recapture studies. North American Journal of Fisheries Management 24: 146-1459.

The short-term mortality of juvenile Chinook salmon dual marked with fluorescent pigments and Bismarck brown was investigated. There were three treatment groups; spray-dyed with fluorescent pigments, stained with Bismarck brown, or both. Mortality was low for all treatment groups. The dual marked group had the highest acute mortality (0.48%) while cumulative mortality was greatest for the spray-dyed (0.93%) and dual marked (0.84%) groups. Differences in mortality among groups were not significant. Mark retention was 100% for fluorescent pigments. Bismarck brown did not interfere with fluorescent pigments.

Hammer, S. A. and H.L. Blankenship. 2001. Cost comparison of marks, tags, and mark-with-tag combinations used in salmonid research. North American Journal of Aquaculture 63: 171-178.

Different marking and tagging techniques for pacific salmon and their associated costs were compared. The 16 marks compared were: fin clips (adipose, ventral, pectoral, anal, dorsal, and maxillary), freeze brands, elemental marks, thermal otolith marks, and genetic marks. The tags compared were: visible implanted alphanumeric tags and elastomer tags, Floy anchor tags, jaw tags, passive integrated transponder tags and coded wire tags.

Hobbs, J.A., G. Castillo, G. Tigan, J. Lindberg, N. Ikemiyagi, and G. Ramos. 2012. Tagging the next generation: validation of trans-generational chemical tagging for an endangered fish. Environmental Biology of Fish 95: 463-468.

Offspring of delta smelt were marked by peritoneal injection of ripe females using two concentrations of strontium. Chemical mark incorporation was tested using otolith microchemistry (strontium concentration and strontium isotope ratios). The high-concentration treatment had otolith strontium concentrations and strontium isotope ratios that were significantly different from the control treatment while the low concentration treatment did not. There were negative effects of the high concentration treatment on larvae. Yolk and oil globule diameters were significantly reduced and growth rates were significantly reduced after 60 days post-hatch. Offspring of delta smelt can be marked using strontium but chemical concentration and dosage should be considered due to the negative effects of the high concentration treatment that were observed.

Mohler, J.W. 2003. Producing fluorescent marks on Atlantic salmon fin rays and scales with calcein via osmotic induction. North American Journal of Fisheries Management 23: 1108-1113.

Larval and post-scale developmental life stage Atlantic salmon were marked with calcein using "osmotic induction" (sequential immersion in salt and calcein solutions). Larvae at 47 day post-treatment of calcein had mortality and growth not significantly different than non-exposed fish. There was no observed mortality of parr Atlantic salmon 120 d post-treatment with calcein. Calcein produced distinct marks on fin rays of larvae and parr, and on scales of parr. Calcein marks are invisible to the naked eye; they require application of UV light to be visible. Fish marked with calcein can be observed without needing to sacrifice the fish.

Peters R.J., E.E. Knudsen, and G.B. Pauley. 1994. Effects of freeze branding on growth and survival of coho salmon fry. U.S. Fish and Wildlife Service, Olympia, Washington.

http://www.fws.gov/wafwo/fisheries/Publications/FP117.pdf

Coho salmon fry were marked using carbon dioxide freeze branding. Branding did not significantly affect survival or growth of coho salmon fry if they survived initial handling (8.3% initial handling mortality). Brands were no longer distinguishable after 6 weeks.

Schumann, D.A., K.D. Koupal, W.W. Hoback, and C.W. Schoenebeck. 2013. Evaluation of sprayed fluorescent pigment as a method to mass-mark fish species. The Open Fish Science Journal 2013: 41-47.

Fluorescent pigment forced into dermal tissue with compressed air was evaluated as a technique for mass-marking fish. Six fish species were used to evaluate mark retention, readability, and mortality in a five month trial. Marking mortality ranged from 0 to 100% and was size dependent for half of the species. Mark retention varied by species and ranged from 6 to 65 % after five months. Growth of marked fish was significantly decreased compared to control fish for 2 species. None of the species used

were salmonids (channel catfish, bluegill, grass carp, black bullhead, plains topminnow, and orange throat darter).

Topping, P.C. and M.S. Zimmerman. 2013. Green river juvenile salmonid production evaluation: 2012 annual report. Washington Department of Fish and Wildlife, Olympia, Washington.

http://wdfw.wa.gov/publications/01529/

Salmonids were marked for rotary screw trap efficiency trials as part of juvenile salmonid production estimates for the Green River, Washington. Natural origin Chinook and coho salmon, and steelhead captured in the trap for the first time were used for efficiency trials. Chinook salmon fry were marked with Bismarck Brown dye while larger juvenile Chinook salmon (parr and smolts), coho salmon, and steelhead were marked with a partial caudal fin clip.