Participating Agreement #: 00-PA-11050500-003
USFS 2004Thermal Refugia Pilot Project

The Northern California Resource Center provided field crew members and a crew leader to complete the preliminary investigation of potential thermal refugial areas in the lower Scott River, per agreement.

Objectives:

The long-range goal of thermal refugia investigation is to assess summer rearing habitat on a sub-basin scale in terms quantity and quality, to determine the utilization of these habitats by Salmonids and to identify possible restoration opportunities (J.Kilgore, personal communication).

The short-term objective of the 2004 Thermal Refugia Pilot Project was to develop and field test a study method that identifies the field method, necessary equipment and person hours required to implement a full scale investigation for the 2005 summer season when potentially thousands of juvenile Coho salmon fry may be in the Scott River watershed (based on the expectation that the 2004-5 adult run will be robust). The tasks include:

1. Identify thermal refugia habitats at mouths of main tributaries, using the Aerial Thermal Infrared Survey (FLIR) data in the lower Scott River and to identify "paired" habitats with similar habitat characteristics.
2. Develop a method to measure the habitat surface area and volume of each identified site.
3. Develop method to measure temperature throughout thermal refugia and in the paired habitat site.
4. Evaluate the habitat characteristics of each identified site.
5. Map, flag and GPS each site.
6. Photo document each site.
7. Develop field method to quantify fish utilization by species and age class at each site by snorkel survey.
8. Identify potential thermal refugia areas in the lower Scott River not identified by the FLIR data.
9. Investigate stratification in deep pools.

Study Area:

The lower Scott River from just above the confluence of Boulder Creek, river mile (RM) 16.1 to Cabin Hole, RM 4.8 was the range of the investigation. Tributary confluences at Boulder Creek, Canyon Creek, Kelsey Creek, Middle Creek, Tompkins Creek and the hillslope seep area just above Cabin Hole were investigated. Additionally, the hillslope seeps between Boulder Creek and Canyon Creek, below Canyon Creek and pools from Townsend Gulch to Gold Flat and at RM 9.2 above Sugar Pine Gulch were sampled.

Initial field investigations began on August 5, 2004. On August 12, 2004, a cooperative effort, with support from Calib Gilbert, NOAA Fisheries, Justin Ly, NRCS and Mark

Pisano, CDFG took place. Most of the field work occurred between August 19-26, 2004. Unfortunately, this was a week with plummeting air and water temperatures due to an unexpected cold front, which affected refugia dimensions and fish behavior.

Methods:

This pilot project tiered off a previous thermal refugia investigation in this same area (Pisano, 2002), work in the Klamath River by the Yurok tribe (Belchik, 2002), a study in northern California coastal streams (Nielson, 1991) and the recent FLIR data provided by the California North Coast Water Quality Assessment Board (2003).

Four types of refugia areas were identified by Nielson: mouths of tributaries, hillslope seeps, stratification of pools and intragravel upwellings. The FLIR data indicated cold water influences at the mouth of tributaries and at some hillslope seeps. Temperatures below the water surface were not picked up by this technology. A 2^0C difference between the ambient river temperature and the mixed water from the cold water source was the criteria used to determine the boundary of the refugia. This was based on the field work done in 2002 and an adaptation from Nielson, who identified a 3^0C average difference.

Tributary Mouths

Thermal refugia and the habitat units that included the refugia were assessed at five tributary mouths. Boulder Creek had limited habitat at the confluence and was not selected as a sample site for continued investigation. Near each of the other four refugia habitats a "paired" habitat was also identified and assessed. A "paired" habitat is one that has similar habitat characteristics as the refugia habitat. This includes dimensions (length, width, depth and maximum depth), instream cover, substrate and gradient. The refugia area is identified by the letter "A" and the paired habitat by the letter "B" (i.e. Canyon 1A and Canyon 1B).

At each tributary mouth, the boundary of the cold water influence was delineated using a YSI 30 digital conductivity/temperature meter with a 10 ft. probe which recorded temperature. This meter responded immediately to changes to the nearest $1/100^{th}$ of a ^{0}C. One person identified the perimeter of the refuge, using the 2^0C criteria and the other mapped and measured the area. The entire habitat including the refugia was mapped, from stream bank to stream bank and from the top of the tributary influence to the bottom of the influence. Dimensions and instream cover were recorded at most sites. All sites were GPS'd at the upstream end, photographed upstream from the bottom and downstream from the top and flagged at the top and bottom for future work.

Ideally, snorkel surveys would occur within the entire habitat area, but changes in weather conditions and insufficient time prevented accurate investigation of this aspect of the pilot project, as discussed further in the Discussion section of this report.

The following tributary refugia and paired habitats were identified:

Site	River Mile
Canyon Creek 1A	15.6
Canyon 1B	15.3
Kelsey Creek 3A	14.5
Kelsey 3B	14.75
Middle Creek 4A	12.7
Middle 4B	12.8
Tompkins Creek 5A	11.4
Tompkins 5B	11.2

Thermisters were deployed in two of the paired sites: Canyon Cr. 1A and 1B and Kelsey Creek 3a and 3B to compare temperatures between the refugia and paired site.

A detailed temperature investigation of the Canyon Creek 1A refugia was undertaken on August 12, 2004 by agency partners, Justin Ly, NRCS, Mark Pisano, CDFG and Calib Gilbert, NOAA Fisheries. A longitudinal tape was stretched from the top of the cold water influence of Canyon Cr. to the downstream end of the influence. At 5 meter intervals, a tape was stretched from the left to the right side of the wetted channel, perpendicular to the longitudinal tape. Temperatures and water depths were measured at 1 meter intervals across these transects using the YSI 30 digital thermometer and a depth gauge. Values were recorded and mapped. See data in Field Data Section.

This detailed mapping helped identify the location of thermisters that were deployed on August 24, 2004 across the transect at the broadest width of the refugia. Four Hobo Temp Pros were placed at 3.0, 8.0. 9.5 and 12.5 meters out from the left bank, set at 2 minute intervals for recording. These locations represented temperatures on August 12, 2004 of 15.7, 16.1, 18.0 and 20.0 respectively.

Thermisters were placed above Boulder Creek (RM 16.1), above Canyon Creek (RM 15.6), opposite Canyon Creek on river right (RM 15.6) and below Canyon Creek (RM 15.3). These were all set at a 1 hour interval for recording.

All thermisters used in the project were calibrated at a 0^0 C ice bath and at room temperature. Calibration files are included in the data set.

Hillslope Seeps

Some known hillslope seep areas were investigated during 2004. These areas were identified in 2002 or known from previous fisheries work in the Scott River. These seeps are located between Boulder Creek to above Canyon Creek (RM 16.0-15.8), below Canyon Creek (RM 15.6-15.5) and at Cabin Hole (RM 4.8-4.9). Other locations may exist, but were not investigated during this pilot project. Temperatures were recorded at the source of each of these seeps and an attempt to delineate the boundary of the cold water influence was made. Photos were taken at most sites. There are several seeps at

Cabin Hole, RM 4.8. This site was mapped as site 6A and a paired habitat upstream of the site, without seeps was identified as 6B.

Pool Stratification

Nielson identifies a refugia type that is created by stratification of deep pools generally near the source of cold water (mouth of tributary). Some deep pools were investigated for stratification using a Hanna HI 9063 K-thermacouple thermometer with a 20 ft. probe. The probe was attached to a weighted cord with depth increments marked at 0.5 meter intervals. Using a small rubber raft, temperatures were recorded at various depths from the surface to the bottom. Pools between Townsend Gulch and Gold Flat were evaluated for sampling, but none were found to be suitable. Initially, it was assumed that pools would be found with stratification and that thermisters would be deployed at various depths to monitor changes in temperature. These potential sites required a minimum of human disturbance during the summer, which eliminated main swimming holes from the sample set. However, the pools that were identified in the field did not appear to stratify at the time temperatures were measured. The pool at RM 9.2 held the most promise as an initial site, but only changed temperature by 0.1 C^0 from the surface to the bottom. Snorkel observation also occurred at this site.

Using the USFWS 2002 Habitat Typing data, the pools with depths > 3.1 meters have been located on a map for future investigation. See Table 2 in Results under Pool Stratification.

Results:

Tributary Mouths

Four sites and their paired habitats have been identified and mapped for future investigation. Each paired site provides the best similarity of habitat characteristics within close proximity to the refugia site. See Table 1: Habitat Data.

The results of the thermister temperature cross section at Canyon 1A shows the dynamic nature of these refugia areas, both diurnally and over several days. Graph 1

Temperature differences between the refugia area and the paired habitat are shown for Canyon Cr. and Kelsey Cr. (Graph 2 and 3, respectively).

The mouth of Boulder Creek was investigated on August 5, 2004. Because of the limited habitat directly at the confluence, it was not selected as a site for further investigation with paired habitats. The influence of Boulder Creek, Canyon Creek and hillslope seeps nearby may serve as a larger refugia area over this entire reach of river. With this in mind, thermisters were deployed upstream, downstream and within this reach. Temperature comparisons from above Boulder Creek (RM 16.1) to below Canyon Creek (15.3) are shown on Graph 4. Unfortunately, the thermister placed opposite Canyon Cr. on the far right side of the channel malfunctioned, providing no data.

Table 1:

KNF 2004 Thermal Refugia Pilot Study
Habitat Data

Site Name	Site #	River Mile	Temperature ^{0}C				Dimensions of Refuge					Dimensions of Entire Habitat						Instream Cover		Date	Time	Crew	Comments
			River	Edge	Mid	Source	Length (m)	Width (m)	Ave. Depth (m)	Max. Depth (m)	Vol. (m^3)	Length (m)	Width (m)	Ave. Depth (m)	Max. Depth (m)	Vol. (m^3)	% Refuge/ Entire Hab	%	Type				
Canyon	1A	15.6	18.5			14.5	44	9.75	0.5	1.3	214.5	44	18	0.5	1.3	396	54.16666667	35	5,7,8	8/23/2004		S.Maurer W.Beaver	Rainy, overcast day. Air temp=18^{0}C. Step-Run/Glide/Pocket water habitat.
Canyon	1B	15.3	16.5								0	47	18	0.46	1	389.16		30	8	8/24/2004		J.Bowman C.Bowman S.Maurer	
Kelsey	3A	14.5	24	21	20	19	17	6.1	0.7	1.4	72.59	58	12.3			0		10	7,8,9	8/19/2004		J.Bowman C.Bowman S.Maurer	
Kelsey	3B	14.75	18.2									102	15.4	1.1	1.86	1727.88		15	1,7,8,9	8/23/2004		J.Bowman C.Bowman	Air temp=18^{0}C
Middle	4A	12.7	18.3	17.9	16.2	15.8						31	12.1	0.48	0.82	180.048		25	7,8	8/24/2004		J.Bowman C.Bowman S.Maurer	Side channel on river right not included; less than 15% flow. Two seeps just upstream of confluence.
Middle	4B	12.8	16.9									19.7	15	0.5	0.8	147.75		30	7,8,9	8/26/2004		S.Maurer J.Warner	Middle Cr Temp= 14.9^{0}C
Tompkins	5A	11.4	17.2			15.5						49	19	0.7	1.2	651.7		20	7,8,9	8/26/2004	1244	S.Maurer J.Warner	Step-Run Habitat
Tompkins	5B	11.2	18.1									46.7	17	0.8	1.3	635.12		20	7,8,9	8/26/2004	1430	S.Maurer J.Warner	
Cabin Hole	6A	4.8	19.7									145	13.54		3.3			5		8/26/2004	1230	J.Bowman C.Bowman W.Beaver	Many seeps along river left; have approx. 0.9 m^2 influence into the river. Lots of cloud cover; air temp= 12^{0}C.
Cabin Hole	6B	4.9	20.9															7		8/26/2004	1500	J.Bowman C.Bowman W.Beaver	Upsteam of 6A; flagged and photos only, due to time limits.

A snorkel survey of Kelsey 3A on August 19, 2004 and 3B on August 23, 2004, showed the following results:

Site	0+ Sthd	1+ Sthd	2+ Sthd	0+ coho	1+ coho	0+ Chin	1+ Chin	Adult Chin
3A	69	25	15	0	0	19	0	0
3B	0	0	0	0	0	1	0	0

An attempt to snorkel Canyon Creek 1A was made on August 23, 2004, but more than two divers were needed to adequately observe the fish. 0+, 1+ and 2+ steelhead were observed throughout the lower portion of the reach where snorkeling occurred.
No other biological observations at tributary mouths or their paired habitats were attempted due to the climatic changes and the lack of time.

Hillslope Seeps

Several seeps from just above Boulder Creek to above Canyon Creek along the left bank of the Scott River were identified in 2002. Three of these seeps were revisited on August 5, 2004. The ambient river temperature was 20.4 ^{0}C in the afternoon on this day.

Site #4 (lowest of seeps) had completely filled in with fines since 2002. (See photo: SR_BoulderSeeps_4_080504_1). There was no holding habitat or fish observed in the now limited refugial area. The results of a snorkel survey from approximately 35 meters below and up to the seep on the left half of the river are shown in the table below:

Seep	0+ Sthd	1+ & 2+Sthd	0+ coho	1+ coho	0+ Chin	1+ Chin	Adult Chin
Site #4	50	150	1	0	0	0	0

The source of this cold water exits the ground above the river surface on the hillslope approximately 6 meters away and carves a small channel through the sand and vegetation to where it joins the river. The temperature at the source was approximately 13 ^{0}C.

Site #3 (next upstream seep) was more difficult to relocate from the 2002 survey. The source appears to join the river somewhere subsurface, near large boulders on river left. There were pockets of cold water .25m x.25m that ranged in temperature from 15.3 to 18^{0}C, which moved around within this area. Many fish utilized this area including all age classes of steelhead and 0+ Chinook salmon, but no coho salmon were observed. (See Photo: SR_BoulderSeeps_3_080504).

Site #2 is the mouth of Boulder Creek. The discharge was estimated to be < 5cfs. At the confluence, the stream fans out over cobbles and a portion of the flow goes down a small, shallow side channel on the far left of the river. There was little habitat and was therefore determined not to be a good site for further investigation. The refugia line opposite the

confluence was easily determined using the YSI probe. The area was quite narrow, however, and ranged from 13.1 to 20.4 ^{0}C over a 0.5 meter width before it went under large boulders. All age classes of steelhead were observed, but the 0+ were especially visible just inside the refugia line described above. They appeared to hold in 16-17 ^{0}C water rather than at 13.1 ^{0}C closer to the source. An underwater photo of the fish beneath the large boulders is included (SR_BoulderSeeps_2_080504).

There are as many as nine seeps along the left bank below the mouth of Canyon Creek (RM 15.6), as noted on August 11, 2004. These may all be hyporheic flow from the Canyon Creek alluvial fan, but bear further investigation. The temperatures range from 13-15 ^{0}C; 16 ^{0}C in Canyon Creek itself. Although the discharge is small at each seep, the collective contribution may be significant.

Pool Stratification:

None of the pools investigated this season were stratified.
A map of pool locations with depths >3.1 meters was generated using the USFWS 2002 Habitat Typing data. These are located between river mile 4.0 and 19.3. The location of each pool was calculated by totaling habitat lengths from this data set, then plotting the distance on a USGS quad map. The location of the pools appears to be slightly further upstream, using this method, than the actual location based on some notes in the comments field of this data set. All of these pools should be investigated for stratification during the heat of the season in 2005, especially those that are near possible cold water influences (tributaries and seeps).

Table 2:
KNF Thermal Refugia Pilot Project
Location of Pools > 3.1 meters as identified by USFWS Habitat Typing Data, 2002

HU #	Pool Type	Max.Depth (m)	River Mile	Landmark
3	LSP-BR	4.42	0.06	Hwy 96
74	LSP-BR	3.81	4.03	
109	LSP-BR	4.15	6	
121	MCP	3.26	6.54	McGuffy Cr.-left
137	LSP-BR	3.17	7.3	unnamed trib-left
142	LSP-BR	5.12	7.6	
143	LSP-BR	3.11	7.72	
147	LSP-BR	4.42	7.8	George Allen Gl.-left
148	LSP-BR	3.17	7.85	Schuler Gl.-right
184	LSP-BR	3.57	9.87	
199	LSP-BR	4.27	10.6	
210	LSP-BR	4.66	11.48	Scott River Lodge?
266	LSP-BR	3.2	14.1	unnamed trib-right
273	LSP-BR	3.11	14.43	
287	LSP-BR	3.72	14.85	Bridge Flat
345	LSP-BR	3.41	18.4	
353	LSP-BR	3.41	19.33	

Discussion:

Due to a cold front that moved in and dropped ambient river temperatures to 18.5^{0}C in the later part of August when most of the field work took place, refugial dimensions and fish utilization were not as they would have been when the ambient river temperature is over 22^{0}C. The identification of all possible refugial areas in the lower Scott River was not possible during this pilot project due to limited time and money.

Identifying a minimum of eight sites with paired habitats and monitoring those sites intensely during the hottest summer periods, ideally for 6-8 weeks is one of the goals for 2005 (R.Quiñones, personal communication). Four tributary mouth type refugia areas (Canyon, Kelsey, Middle and Tompkins creeks) and one hillslope seep type refugia (Cabin Hole) have been identified. Additional sites will need to be identified to meet the eight site minimum.

Data forms used for this pilot project were developed in 2002. They are included in the Appendix. These forms will need further modification to include data fields identified this season and to include new fields developed for the 2005 field season.

Tributary Mouths

Identifying and assessing the refugia habitats at the mouths of tributaries and their paired habitats was the best that could be accomplished under these climatic circumstances. It is a challenge to delineate the dimension of the refugia area within the habitat. This is necessary in order to snorkel and count those fish within and those fish outside of the refugia. It is evident from the graph showing the cross section temperatures at the Canyon 1A site, that the refugia area is a moving target. It fluctuates diurnally as well as with broader changes in the ambient river temperature. The best time to measure temperatures and corresponding fish behavior is in the afternoon through the early evening, when the temperatures are at their highest.
The challenge is to measure and delineate that space (volume) with some type of marker, such as a weighed line, then revisit the same site in the same afternoon to observe fish utilization (count and identify by species and age class). The detailed method developed on August 12, 2004 by agency partners is quite accurate in characterizing the temperatures throughout the entire refugia at the time the measurement is taken, however, it would take approximately three hours to complete the temperature mapping for one refuge alone. The temperatures could actually change greatly over the course of this time period, not to mention the disturbance to the fish that need to be counted. It seems reasonable to delineate only the boundary area, for the sake of time and disturbance. Initially, this, plus the habitat assessment would take up to three hours per site, but could be streamlined once the sites are identified for subsequent observations. The refugia boundary will need to be delineated each time so that accurate fish densities can be computed.

The snorkel observations that took place this season provided little of definitive value due to the drop in the ambient river temperature. Many fish were observed outside the

refugia area, although many more were observed within. How that differs with very hot temperatures, is yet to be answered. Very few coho salmon were observed this season, which may be different in 2005. 0+ Coho salmon and 0+ steelhead appear to be the most sensitive, according to the 2002 observations in the Scott River canyon.

The primary value of the snorkel observations this season was to test the method. Depending on the habitat, as many as four divers may be necessary to adequately observe the fish. Dives of the refugia habitat, separating fish inside and outside of the refugia and dives of the paired habitat need to occur under the same temperature conditions (the same afternoon/evening). It is estimated that a two person crew could complete two sites/day, once the sites have been identified initially. This would include the temperature delineation at each of the two refugia sites and four dives, one at each refugia site and one at each paired habitat site. Dives at some sites could take up to one hour and may require up to four persons.

Hillslope Seeps:

Only one site of this type and its pair, Cabin Hole 6A & 6B, was formally assessed for habitat characterization. Two other hillslope seep areas were investigated (Boulder to Canyon and below Canyon), but the influence of the tributary streams (Boulder and Canyon Creeks) complicates the evaluation. It may be possible to find a paired habitat for the seeps below Boulder Creek or there may be other suitable hillslope seep locations further downstream in the canyon that have yet to be investigated. The seep above Tompkins Creek, identified in the FLIR data, should be investigated (Scott River Lodge). Geologists, Don Elder and Polly Haessig, KNF, suggest looking at the KNF landslide GIS layer where toes of landslides reach the river as potential seep areas. This map layer and data set are included in the Appendix for use in the location of these sites.

Pool Stratification:

The stratification of pools in the Scott River needs further exploration. Now that the location of deep pools have been mapped (USFWS, 2002 Habitat Typing), they will be possible to investigate more strategically. Two crew members, using the Hanna meter and 20 ft. probe, a raft and wetsuits should be able to investigate the seventeen pools that have been mapped over a 3 day period. If stratification is observed, it will be important to determine if there is a cold water influence nearby (i.e. intragravel seep, mouth of tributary) If found, paired habitats also need to be located and assessed that are similar in habitat quality and pool dimension. Thermisters strung vertically in the water column should be considered, as well. Finding and setting up stratified pools for intensive observation could take two people up to one week total time.

Suggestions:

The following list of suggestions include tasks that a project leader should consider before the field season begins, suggested tasks during the field season and the person hours estimated to accomplish these tasks.

1. Both long range and short-term objectives for this project need to be clearly defined in advance of the field work. Time unknown.
2. Coordination with all entities investigating thermal refugia within the Scott River Watershed is necessary in order to standardize the methods, reporting formats and to share information. Time unknown.
3. Landowner access may be required and will take time to secure. Time unknown.
4. A thorough investigation throughout the entire Scott River watershed is needed in order to completely map all thermal refugial areas. By snorkeling with pocket thermometers and using a bare hand, it is possible to initially detect subtle temperature differences in the water. Intragravel seeps, hillslope seeps, stratified pools and mouths of tributaries not identified in the FLIR data may exist. Target areas for investigation can be identified using a combination of the following information: FLIR data, USFWS 2002 Habitat Typing data for pool depths and geologic data for likely locations of cold water sites (i.e. toes of landslides that reach the river). Mouths of minor tributaries that did not show cold water influences with the FLIR data could be investigated for subsurface contributions. This will require many persons, working in teams of two over the course of one or two days in the afternoon. Teams can probably cover 2 miles/day thoroughly, if they work into the early evening. By targeting specific areas, this may be streamlined.
5. Check all identified pools >3.1 meters for stratification and if stratification is found, assess habitat and locate paired habitat site and assess. 2 persons/1 week
6. Complete the identification of the remaining 3-4 sites (total of 8) and their paired habitats. This can be an outcome of #4 above. These may include seeps and pool sites, once identified. 2 persons/3 days
7. Monitor the 8 sites and their paired habitat sites 2x/week for a minimum of 4 weeks during the highest temperature period (probably late July, early August). This will take at least 4 persons/1 week.
8. Deploy thermisters in:
    a. all sites and paired habitats (16)
    b. x-section in refugia in 2 sites (8)
    c. vertically in water column in 2 stratified pools, if found (8)

    The total number of thermisters required may be less than indicated depending on the sites found.

Here are some unanswered questions that may help define future projects:

1. Are the same fish using the same refugia from day to day? Within each day?
2. Do the fish move in and out of the refugia throughout the day and night?
3. How much refugia time does a fish need? Can they move out of it to feed, then return, for example? Does this vary by species?

4. How frequently to dive? Yuroks 1x/hr from 0700-1900; noted increases in use from 1100 and spike at 1500.
5. What other components of habitat account for the fishes' use of the refugia besides temperature? (i.e. food, cover)
6. What is a refuge? Just the cold area or the entire reach around a cold area?
7. Is the entire reach from Boulder Creek to below the last seeps below Canyon Creek a refugia?
8. Does a pool that stratifies, need some source of cold water to feed it?
9. Should surface area or volume be used to compare and evaluate sites?

Equipment:

Each crew should have the following equipment:

GPS unit
Digital and underwater camera
Flagging
Pocket thermometer
Digital thermometer-YSI or Hanna with minimum of 20 ft. extension
Stadia rod
Reel tape- 100 meter
Field maps
Tatum
Wet suit
Mask and snorkel
Wrist slate/tally counter
Data forms
Rubber raft

References:

"Aerial Thermal Infrared Survey Scott River Sub-Basin", California North Coast Water Quality Assessment Board, et al., July 25-26, 2003.

Belchik, Michael R. and Turo, Scott M. "Summer use of cold-water refugia areas by Juvenile and Adult Salmonids the Klamath River, California in August, 2002", Yurok Tribal Fisheries Program. 2002.

Belchik, Michael R., et al. "Klamath River Thermal Refugia Study Summer, 2002", Yurok Tribal Fisheries Program. December 9, 2002.

Nielson, Jennifer L. "The Role of Cold-Pool Refugia in the Freshwater Fish Assemblage in Northern California Rivers", Proceedings of the Symposium on Biodiversity of Northwestern California, October 28-30, 1991, Santa Rosa, CA.

Pisano, Mark. "Juvenile Salmonid Use of Thermal Refugia in the Lower Scott River, 2002; A Cursory Investigation", California Department of Fish and Game. September 21, 2002.