**Supplemental Report 2: Methodology and assumptions used in the recreational greenling fishery bag limit analysis (October 2011)**

## Executive Summary

An Initial Statement of Reasons (ISOR) document is being prepared for California's statewide greenling fishery that will address changes to both the commercial and recreational sectors as a result of an increased annual allowable harvest amount. The Department estimated recreational harvest of greenlings at three bag limit levels: two-fish (status quo), five-fish, and 10-fish. RecFIN raw data were used for the recreational bag limit analysis where two time periods were compared: 1995-2001 and 2009-2010. These two periods were chosen because the first was during a time when there was an existing 10-fish bag limit per angler per day, and the fishery was much less regulated, while the second period covered a recent time period when the bag limit was two fish per angler per day. Data were identified and summarized by bag type; 1) bags that contained greenlings and 2) zero bags where no greenlings were part of the bag, but the potential that greenling could reasonably have been taken as part of the fishing trip. Bag type categorization took into consideration fishing mode, target species, actual species making up a bag, greenlings returned, and the number of anglers contributing to a bag. Bag types were summed (binned) by the number of greenlings per bag (from 0 to 14, with 14 being the highest encountered) and percentages per bin were then calculated compared to the overall total number of bags. These simple percentages were then applied to the highest possible recreational allocation of the TAC to estimate the amount of greenlings (percent of the proposed TAC allocation amount of approximately 50 mt) that likely would be harvested by the recreational sector at the two, five, and ten fish bag limit amounts. The estimated amounts, based on the above, work out to:

two-fish bag limit = 44,300 pounds (40.2% of the TAC allocation)
five-fish bag limit = 51,600 pounds (46.8% of the TAC allocation)
ten-fish bag limit = 52,500 pounds (47.5% of the TAC allocation)

## Methodology

► RecFIN raw sample data were extracted and downloaded from the public web page for two time periods: 1995-2001 and 2009-2010

- 1995-2001 was used as a base comparison time period because during those years there was a greenling ten-fish bag limit. These data were from the Marine Recreational Fisheries Statistical Survey (MRFSS).
- 2009-2010 was chosen as a recent period because a greenling two-fish bag limit was in place and landings were very equal to or above the annual TAC allocation amount of 15.5 mt for those years.
- 2009-2010 RecFIN estimate data for greenlings were also extracted from the California Recreational Fisheries Survey (CRFS)
- For each time period, three types of data were extracted: type 1, type 2, and type 3 so that summaries captured the header data and the A(kept)+B1(unavailable dead)+B2 (released alive) fish
  - Northern California (north of Point Conception) data were used (sub_reg = 2)

- All modes and fishing areas within sub-region 2 were included
- Data were extracted and downloaded as comma delimited text files and converted into Access tables capturing all fields
    - Type 1 records (header information)
    - Type 2 records (B fish) – fish returned
    - Type 3 records (A fish) – fish that were kept and available for inspection

▶ Using Access, two tables were created for each time period: one table for the type 2 fish and one for the type 3 fish with four identification/update fields added to each table

- A "Type" field was added to identify all "A" fish (type 3 records) or "B" fish (type 2 records) based upon the extracted record type (3 or 2)
- A "Trip type" field identified and was updated with a "Y" for any record where:
    - greenlings (kelp, rock, genus, or family) were in the SP_CODE field
    - greenlings were identified in the PRIM1 or PRIM2 fields
        1. PRIM1 were fish identified by the angler as the primary target for the trip
        2. PRIM2 were the secondary target
- A "Trip type 2" field that identified and was updated for all records that met any of the following criteria (using the Trip type 2 sub-codes as follows):
    - 1 = records where PRIM1 or PRIM2 were greenling
    - 2 = records where the SP_CODE (species code) was a greenling
    - 3a = records where the MODE_f was 2 or 5 (beach/bank) and PRIM1 or PRIM2 was cabezon, lingcod, rockfish genus, or monkeyface prickleback
    - 3b = records where the MODE_f was 2 or 5 and the SP_CODE was greenling, cabezon, lingcod, rockfish genus, or monkeyface prickleback
    - 3c = records where the MODE_f was 5 and the SP_CODE was any shallow nearshore rockfish
    - 4a = records where the MODE_f was 6, 7, or 8 and PRIM1 or PRIM2 was any shallow nearshore rockfish, cabezon, or monkeyface prickleback
    - 4b = records where the MODE_f was 6, 7, or 8 and the SP_CODE was any shallow nearshore rockfish, cabezon, or monkeyface prickleback
- A "GL" field that identified and was updated for any record that had greenlings in the SP_CODE field
- All records that had a "Trip type 2" identifier as per any of the above were then used to update all "Trip type" records to a "Y" status – meaning that any bag/trip that was updated to a "Y" status (as per above) was identified and categorized as one that either had greenling as part of the bag or had the potential to have had a greenling
- Therefore, all records with a "Y" in the "GL" field were identified as greenling bags and any record with a "Trip type" identified as a "Y", but had a null value for the "GL" field were identified as a zero greenling bag
- Once a record was identified accordingly, all the records belonging to that bag (based on the same bag ID_CODE number) were updated so that each bag (in its entirety) had a uniform "Trip type" code identifier

► Using both the updated main A fish and B fish tables, greenling COUNT tables were created that summed the number of greenlings per bag (based on the ID_CODE (using the Group By query function)) and the number of anglers per bag (using the CNTRBTRS (number of contributors – or anglers) field).

- It needs to be noted that a number of sub-steps were used to create the greenling COUNT tables and these are not included here at this time
- Aggregate bags (bags with more than one angler) were factored in by dividing the number of greenlings per bag by the number of anglers resulting in many bags with a fractional amount of greenling(s) per bag
- Many bags had a zero or null value in the CNTRBTRS field and to correct for this a temporary table was created for A fish and B fish where the ID_CODE records were grouped and the CNTRBTRS was also grouped (where CNTRBTRS was >0 or not null). The temporary table and main tables were then linked and the main tables were then updated for those records missing a CNTRBTRS value. This yielded a more robust anglers/bag set of data which were used to update the 0 or null values in the A and B fish greenling COUNT tables. Type 1 records were not used because many records in those database tables also had 0 or null values in the CNTRBTRS field.
- As such, it was simpler to adjust for missing CNTRBTRS values by using the above method

► Bins were then set-up that summed the number of bags (again, based on the grouped ID_CODE) for all potential greenling trips where greenlings were not part of the bag (zero bag trips) and those where greenlings made up part of the bag

► After the bin counts were completed, the estimated take at the two-fish, five-fish, and 10-fish levels were calculated for the base period using the following:

- A summed total (count) for each bin was calculated using this summary method:
  - 0 bags – no greenlings per bag
  - 0.01 – 1 greenling per bag
  - 1.01 – 2 greenlings per bag
  - 2.01 – 3 greenlings per bag
  - etc. until no greenlings were encountered
- A percent for each bin was calculated from the overall total number of bags (including those categorized as zero bags) with a cumulative running total noted at the two-fish bag level, the five-fish bag level, and at the 10-fish bag level
- I also calculated a percent for each bin where I used only those bins where greenlings were part of the bag (no zero bags were included) – it was this version that I chose to use (see Assumptions section)
- For this base period, the percent difference between the two-fish, five-fish, and 10-fish amounts were noted
- Using the same method for the two-year recent period, I calculated the two-fish bin percentage, but for this amount, I included all bags that were in excess of the two-fish bin as part of the two-fish percentage (see Assumption section)

- To this amount, I factored in a 20% buffer amount (i.e. the calculated percentage was increased by 20%) and multiplied this higher percentage times the 50 mt new TAC allocation amount to estimate the status quo amount – this became my starting point for the estimated harvest amounts
- To this two-fish percentage I then added the difference between the two-fish and five-fish percentages from the base period to get a hypothetical five-fish bin percentage
- I multiplied this five-fish percentage times the 50 mt amount to calculate that estimated harvest amount
- To this five-fish percentage I then added the difference between the five-fish and 10-fish percentage from the base years and multiplied this amount times the 50 mt amount to estimate the harvest amount with a 10-fish bin

**Assumptions for the Model**

- This is an extremely simplistic and hopefully straightforward model
- The RecFIN bag analysis tool was not used because Department staff have concerns about possible flaws in the analysis tool, instead we used the raw RecFIN sampling data and construct a simple model instead
- Analyzing RecFIN data and modeling can be extremely complex and, as such, it was decided to use the simplest method that time (and lack of expertise) allowed
- Since this model estimates (predicts) the amount of fish that potentially would be taken, all A fish (those retained in the bag), and B1 and B2 (fish returned dead or alive or eaten or given away, etc.) were included
- Only the northern section of the state (north of Pt. Conception) were used since very few greenlings are taken in the southern section
- It is assumed that the number of bags per bin reflects a proportional amount of greenlings that would be taken
- Zero bags were identified using the above criteria to ascertain the number of bags (trips) where greenlings could have reasonably been taken as part of the fishing trip taking into consideration the mode and associated species for the mode and the those actually in the bag or those identified by the angler and returned
    - Various criteria could have been devised - all giving different results
    - A comparison run made using the RecFIN analysis tool did, in fact, indicate substantial differences; some of these differences could be explained due to different criteria used for this model run compared to those assumed used in the RecFIN analysis tool algorithm (we don't know what those are, however), and others that could not be explained
    - The associated species used in the categorization criteria focused on those species commonly caught or potentially could be caught with greenlings from the same fishing area, method of catch, and habitat
- Since the 2009 and 2010 annual average is 16.3 mt (estimate data from RecFIN website), it is assumed that, for 2012 and 2013 with a status quo two-fish bag limit, the annual take would probably be at least 16 mt

- Using a 2009-2010 period rather than a 2007-2010 period (as was first considered) yields slightly larger estimates
    - Therefore, by using these slightly larger estimates, if we err we do so on the cautious side
- A 20% buffer was factored in because:
    - Annual recreational harvest of greenlings has increased during the last three years (Figure 1) and it is felt that future (2012-2013) catches might also increase with the knowledge by anglers that the bag limit is greater (assuming it is set at a level greater than the current two-fish amount) and basing the analysis on these higher years provided the most conservative estimate possible, although at two fish, the estimated catch is higher than what would actually be allowed (based on the current allocation)
    - It is assumed that an increase in future years will fall somewhere less than 20 percent above the calculated amount (a form of latent capacity)
- Percentages for the 1995-2001 base year period were calculated to compare with results calculated from the recent period
- For the base period, I chose to use the differences between bin percentages where only bins with fish were used (I excluded the zero bins) because this yielded slightly higher percentage differences – again to err on the side of caution
- The recent two-year period (2009-2010) was used to do the actual calculations for the estimates because:
    - The RCG complex was in place with a 10-fish bag sub-limit within the overall 20 fish bag limit, whereas it didn't exit during the 1995-2001 base period
    - Within the current RCG 10-fish sub-bag limit, it is felt that many, if not most, anglers have preferred and will continue to prefer and target rockfish and/or cabezon rather than greenlings.
    - When calculating the two-fish bin percentage, I included all those bins that were in excess of the two-fish bin size as part of the two-fish bin size and percentage with the assumption that for these bins:
        1. they were technically illegal bags and, thus, should have been at the two-fish bag amount
        2. in the future these bags (translation – these anglers), will adhere to the regulations and not exceed the bag limit (even though unfortunately, this does take place every year to some extent and in all likelihood will continue to some extent)

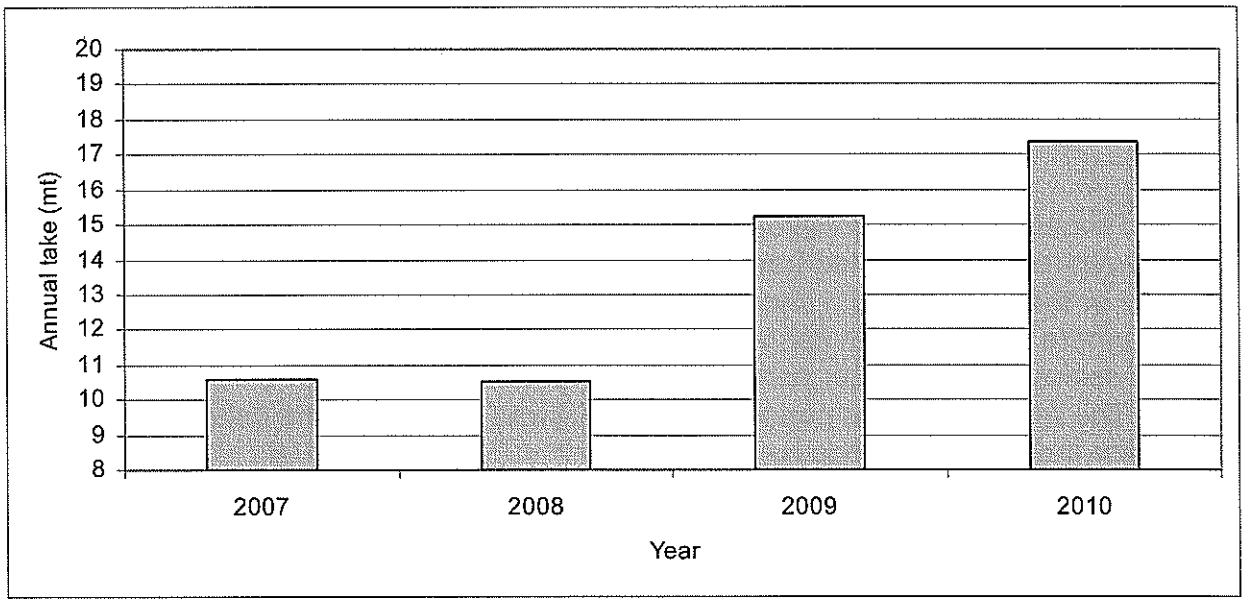


Figure 1. RecFIN estimated harvest amounts (A+B1 in mt) of all greenlings for northern California (north of Point Conception) from 2007 to 2010. All areas and modes are included and data were extracted from the RecFIN web site on Oct. 4, 2011.

prepared by Bob Leos, Oct. 5, 2011