Staff Summary for October 8-9, 2025

2. General Public Comment for Items Not on the Agenda

Today's Item **Information ☒** **Action ☐**

Receive public comment regarding topics within the Commission's authority that are not included on either day of the October 8-9, 2025 agenda.

Summary of Previous/Future Actions

- **Today, receive written and verbal comments and requests** **October 8-9, 2025**
- Consider granting, denying, or referring requests December 10-11, 2025

Background

This item is to provide the public an opportunity to address the Commission on topics not on the agenda. Staff may include written materials and comments received prior to the meeting as exhibits in the meeting binder (if received by the written comment deadline), or as supplemental comments at the meeting (if received by the supplemental comment deadline).

General public comments are categorized into two types: (1) requests for non-regulatory action and (2) informational-only comments. Under the Bagley-Keene Open Meeting Act, the Commission cannot discuss or take action on any matter not included on the agenda, other than to schedule issues raised by the public for consideration at future meetings. Thus, non-regulatory requests generally follow a two-meeting cycle (receipt and direction); the Commission will determine the outcome of non-regulatory requests received at today's meeting at the next regularly scheduled Commission meeting (currently December 10-11, 2025), following staff evaluation.

Significant Public Comments

1. New, non-regulatory requests are summarized in Exhibit 1; original requests are provided as exhibits 2 through 5.
2. Informational comments are provided as exhibits 6 through 17.

Recommendation

Commission staff: Consider whether to add any future agenda items to address issues that are raised during public comment.

Exhibits

1. Summary of new, non-regulatory requests received by September 25, 2025
2. Email from Kathleen Hayden, requesting the Commission recognize *Equus caballus* as an indigenous species, received August 16, 2025
3. Letter from Christopher Hoon, Manager of Government Affairs, Pacific Flyway, Delta Waterfowl Association, recommending the public comment period for refuge-related issues occur at a spring or late summer meeting as opposed to the August

Commission meetings, which take place too close to the start of waterfowl season, received September 5, 2025

4. Letter from Doug Brown, Chairperson, Inyo County Fish and Wildlife Commission, requesting written updates from both the Commission and Department on the steps, procedures, and policies implemented concerning the impact of mountain lion predation on mule deer and Sierra Bighorn sheep populations that was discussed at the June 2024 Commission meeting, received September 22, 2025
5. Letter from Dr. Rikki Eriksen, California Marine Sanctuary Foundation, requesting the Commission revise its marine protected area (MPA) petition evaluation process to bring outdated 2009 level of protection (LOP) standards into alignment with new scientific standards by: (1) Using the MPA Guide as the primary standard for evaluating MPA LOPs, replacing the 2009 criteria; (2) making all historic MLPA Initiative documents publicly available to ensure transparency and equity for all petitioners; and (3) aligning MPA evaluations with contemporary conservation goals such as the 30x30 initiative.
6. Email from Paul Weakland, sharing a YouTube video link discussing elimination of DEI at elite universities, received August 10, 2025
7. Four emails from Tom Hafer, President, Morro Bay Commercial Fisherman's Organization, transmitting articles and web links detailing the current state of offshore wind locations and how it affects fishing industries globally, and the impact a seismic testing project off the central coast of California will have for anthropogenic sound on fish populations, received between August 12 and August 29, 2025
8. Letter from Clayton Oilar, opposing the use of non-lethal methods to control predators in Surprise Valley, Modoc County, received August 13, 2025
9. Email from Gerald Taggart, asking the Commission to reconsider adopting or supporting a chumming flag in California to help reduce shark attacks, received August 24, 2025
10. Email from Thomas Mailey, inquiring about creating a net pen program for stocking rainbow trout and Chinook salmon in Folsom Lake, received September 2, 2025
11. Two emails from Steve Rose, advocating against the euthanasia of a bear known locally as Hope, and provides a poster with safety guidelines for Lake Tahoe residents and visitors on how to coexist with bears, received September 3 and September 4, 2025
12. Email from Charlene Probst, calling attention to a disturbing video shared on social media of a coyote being mauled, received September 4, 2025
13. Two letters from Jim Ahrens and Larry Olagues, President, Kern River Fly Fishers (KRFF), addressed to Chuck Bonham, Department Director, urgently requesting reversal of the Departments current position, which they believe threatens to abandon the fishery in the 16-mile stretch of the North Fork Kern River; citing that existing low flows have created an "artificial drought" with dangerously high water temperatures. KRFF asks the Department to withdraw its support for the current flow regime and advocate instead for scientifically sound, and ecologically appropriate flow increases to restore the river's health, received September 9, 2025

14. Email from James Magill, sharing a letter addressed to Chuck Bonham, Department Director, advocating the use of “active hazing” techniques to mitigate human-wolf interactions to protect both livestock and wolves, received September 9, 2025
15. Letter from David Jinkens, City Councilmember, South Lake Tahoe, sharing a letter addressed to Chuck Bonham, Department Director, respectfully requests the suspension of the proposed lethal removal of a mother bear, known locally as Hope, and the capture of her cub, Bounce. The proposal has sparked deep concern across the Lake Tahoe community, as the Bear League has offered to entirely cover the cost of relocating both bears to a forested area within the Tahoe Basin, received September 16, 2025
16. A representative sample of 20 emails, received between September 19 and September 21, 2025, requesting the Department release a final report on the determination to list mountain lions as threatened or endangered under the California Endangered Species Act
17. Email from Ashley Gerber, providing feedback on the Western Joshua Tree Conservation Plan, and highlighting the need for greater protections and fairness to homeowners experiencing obstacles with permits and staggering fees associated with the relocation or removal of Western Joshua Trees on their properties, received September 21, 2025

Motion (N/A)

California Fish and Game Commission
Receipt List for Non-Regulatory Requests Received by 5:00 PM on
September 25, 2025

Date Received	Name/Organization of Requestor	Subject of Request	Short Description	FGC Receipt Scheduled	FGC Action Scheduled
8/16/2025	Kathleen Hayden	Wild Horses	Requests the Commission recognize *Equus caballus* as an indigenous species.	10/8-9/2025	12/10-11/2025
9/5/2025	Christopher Hoon, Manager of Government Affairs - Pacific Flyway, Delta Waterfowl Assoc.	Commission Meetings	Recommends the public comment period for refuge-related issues occur at a spring or late summer Commission meeting as opposed to the August Commission meeting, which takes place close to the start of waterfowl season.	10/8-9/2025	12/10-11/2025
9/22/2025	Doug Brown, Inyo County Fish and Wildlife Commission	Predator Management: Sierra Bighorn Sheep and Mule Deer	Requests written updates from CFGC and CDFW on the steps, procedures, and policies implemented concerning the impact of mountain lion predation on mule deer and Sierra bighorn sheep populations	10/8-9/2025	12/10-11/2025
9/25/2025	Dr. Rikki Eriksen California Marine Sanctuary Foundation	MPA Petitions Evaluation Framework	Requests the Commission revise its approach to evaluating marine protected area (MPA) petitions by: (1) Using the MPA Guide as the primary standard for evaluating MPA levels of protection (LOP), replacing the outdated 2009 LOP criteria, or at minimum reflecting both; (2) making historic evaluation criteria available publicly; and (3) aligning MPA evaluations with contemporary conservation goals (i.e., the 30x30 initiative).	10/8-9/2025	12/10-11/2025

Outlook

Re: San Diego MSCP excludes native Resource

From Kathleen Hayden <[redacted]>
Date Sat 08/16/2025 10:30 AM
To FGC <FGC@fgc.ca.gov>
Cc Kathleen Hayden [redacted]

Dear Director Miller-Henson, Please accept the correct draft as the original was incomplete.

Aug 15 2025

California Fish and Game Commission Executive Director

[redacted]

(916) 653-4899 or (916) 653-7229P.O. Box 944209, Sacramento, CA 94244-2090

Dear Director Miller-Henson

San Diego's local, state, federal, and MSCP Resource management plans exclude the native Resource of protected wild horses. This requires USFWS reconsideration regarding the statement of: Miner, Karen [redacted] [mailto:[redacted]] To: Kathleen Hayden

"When and if available scientific information convinces the experts that determine the checklist of native species to North America that Equus caballus should be considered as an indigenous species, they will make the change in the next revision to the list, and then we would take that fact into consideration for inclusion on our state animal lists."

https://en.wikipedia.org/wiki/Wild_horse#DistributionScientific naming of the species.

In 2003, the International Commission on Zoological Nomenclature decided that the scientific names of the wild species have priority over the scientific names of domesticated species, therefore mandating the use of Equus ferus for both the wild and the domesticated horse if the two taxa are considered conspecific.

Wild and domesticated horses are often considered conspecific, meaning they belong to the same species, which is scientifically named Equus ferus. However, they are sometimes classified as separate subspecies, with domesticated horses referred to as Equus ferus caballus and wild horses as Equus ferus ferus or Przewalski's horse.

See also, https://www.sciencedirect.com/science/article/abs/pii/S1871141308000747

In some sources including MSW 3 (2005), the domesticated and wild horses were considered a single species, with the valid scientific name for such a single horse species being Equus ferus,[58] although

MSW erroneously used E. caballus for this (enlarged) taxon on account of a mis-interpretation of the then-recent ICZN ruling on the matter,[59] refer Groves & Grubb, 2011.[60] The wild tarpan subspecies is E. f. ferus, Przewalski's horse is E. f. przewalskii, while the domesticated horse is nowadays normally (but not exclusively) treated as a separate species, E. caballus.

https://www.sci.news/?s=przewalski+

While N.America is the native home of the Equis species then does the ancient DNA breeding found in US wild horses qualify them as a Resource in fatally flawed Resource management Plans? … In light of the recent discoveries that the Przewalski horse is a feral species, instead of the last wild horses on the planet. Over 157 Przewalski's horses have been born at the San Diego Zoo and Safari Park, and their offspring have been sent to zoos and reintroduction projects around the world, while America's feral/ wild horses are denied status as a Resource in RMPs.

Please consider Equus caballus as an indigenous species, make the change in the next revision to the list, and take that fact into consideration for inclusion on state animal lists.

Respectfully submitted,

Kathleen Hayden

[redacted]

On Fri, Aug 15, 2025 at 4:20 PM Kathleen Hayden <[redacted]> wrote:

> California Fish and Game Commission Executive Director
>
> Melissa Miller-Henson
>
> fgc@fgc.ca.gov | (916) 653-4899 or (916) 653-7229
>
> P.O. Box 944209, Sacramento, CA 94244-2090
>
> Dear Director Miller-Henson
>
> San Diego MSCP excludes native Resource needs USFWS reconsideration. Former Correspondence rom**:** Miner, Karer[redacted]
>
> **Sent:** Thursday, March 03, 2016 4:18 PM
> **To:** Kathleen Hayden
> **Subject:** RE: CA data base of special concern mammals.
>
> Interesting theory.
>
> When and if available scientific information convinces the experts that determine the checklist of native species to North America that *Equus caballus* should be considered as an indigenous species, they will make the change in the next revision to the list, and then we would take that fact into consideration for inclusion on our state animal lists.
>
> Thanks
>
> Interim Chief | Sustainability Planning Division chelsea.oakes@sdcounty.ca.gov Oakes, Chelsea
>
> Aug 11, 2025, 3:13 PM
>
> Good Afternoon, Kathleen,
>
> Thank you for reaching out. While we understand your email was directed to the Bureau of Land Management (BLM), we would like to reaffirm our position in light of the recent court ruling in Nevada. As previously

discussed, it is the responsibility of the BLM to implement the Wild-Free Roaming Horses and Burros Act and manage associated Herd Management Areas (HMAs). Conversely, the County of San Diego's (County) Multiple Species Conservation Program (MSCP) is intended to provide programmatic compliance with the federal and state endangered species acts and long-term protection of the species protected under those acts. Because the Coyote Canyon Heritage Herd is not currently listed or proposed to be listed under the federal or state endangered species acts, including as a Distinct Population Segment, the County has previously determined that this species does not meet our criteria to be included as a Covered Species within the MSCP. Additionally, there are no existing HMAs in San Diego County and land under County ownership is limited and incontiguous. It is therefore unlikely to support a viable population due to its limited size and distribution.

We appreciate your time in providing your thoughts and concerns regarding the relocation of the Coyote Canyon Heritage Herd. Due to the reasons stated above, at this time the County is not able to assist in your efforts to relocate the herd to public lands.

Thank you.

Chelsea Oakes, MPH, REHS

Interim Chief | Sustainability Planning Division chelsea.oakes@sdcounty.ca.gov

Kathleen Hayden <

to Chelsea, Rami, Tyler, Tai, Marvin, Madison, Jacob, Stephanie, Anne, Crystal, Andrew, Public, Alexander, bcc: melodyo, bcc: Chamise, bcc: me, bcc: Robert, bcc: Dorise, bcc: William, bcc: cathy, bcc: , bcc: Candace, bcc: Bruce, bcc: Atty, bcc: Gus, bcc: Trudy

Chelsea et al,

I am contesting your decision to exclude San Diego's native cultural and historic wild horse herd from the MSCP. The RMP may be fatally flawed for much of the same reasons as Ramona Wildlife Preserve's Resource Management and the Federal Southcoast plan is fatally flawed. Agencies that have neglected to implement the requisites of four acts of Congress do not excuse them from the mandates to include the Coyote Canyon Wild Horses as a native American cultural and historic Resource.

RE Ramona Wildlife Preserve. The owner of the property was the bank sponsor. Mike McCollum and Barry Jones (Rancho Buho, LLC), as joint venture partners in the bank, have successfully established conservation and mitigation banks across southern California, and will be primarily responsible for day to day operation of the Bank." from Agenda Item Four page 9-12 SAN DIEGUITO RIVER PARK JOINT POWERS AUTHORITY Friday, July 19, 2013 County Administrative Center 1600 Pacific Highway, Room 302/303 San Diego http://www.sdrp.org/archive/jpa/Agen071913.pdf

On September 03, 2013, when Barry Jones (the principal biologist for the Ramona Grasslands Conservation bank) was asked to list the Coyote Canyon heritage herd on the inventory list of cultural and natural resources, he replied, "This is something I am not passionate about and am too busy even if I were to be of any assistance. Plus I have never heard of the USFWS listing an introduced species like the horse."

A notice in the federal register dated June 10, 2014, from Friends of Animals and The Cloud Foundation, requesting that the distinct population segment (DPS) of North American wild horses on all U.S. federal public lands be listed as an endangered or threatened species under the Act.

Upon receiving sufficient documentation, California is required to update its historic and native plant/animal inventories. The inventory component is vital to local preservation programs when data is incorporated into the statewide Historical Resources Inventory (SHRI), which includes information on historical resources that have been identified and evaluated through one of the programs that OHP administers under the National Historic Preservation Act or the California Public Resources Code.

Because the designated Coyote Canyon Heritage Herd landscape and has been identified numerous times in local , state and federal management plans, including the Coyote Canyon Public Use Plan, and a nomination to the Federal Register, it meets the criteria for recording as a RESOURCE on the inventory of native and historical and cultural resources in local, state and federal Resource Management Plans such as Multiple Species

Conservation Plans. Agencies must implement the mandated requirements to comply with the mandates to remedy the flawed RMPs.

From webpage "Research on the archaeology of the Santa Maria Valley was conducted at San Diego State University's South Coastal Information Center (SCIC) and at the San Diego Historical Society by Dr. Susan M. Hector, principal investigator. Dr. Hector also obtained and evaluated archaeological and cultural resource studies in the Santa Maria Valley as part of the background research for the restoration project. Based on the results of this investigation, a systematic survey of the unsurveyed properties would most likely result in the discovery of additional cultural resources. During the prehistoric period (the era before the founding of the San Diego Mission in 1769),

Native Americans occupied the Santa Maria Valley for many thousands of years.

The people living in the area at the time of Spanish contact are known as the Kumeyaay people. The Santa Maria Valley was home to the village of Pamo, a large, complex civilization, for many hundreds of years. Pamo was a collective of Kumeyaay Indians living and working areas within Santa Maria Valley. The village was seamlessly integrated into one of the last remnants of extensive grassland habitat in coastal Southern California.

The rich environment within the Ramona Grasslands provided abundant resources for the Pamo villagers. Of particular and unique importance was the native grassland. The plants and animals distinctive to this habitat contributed toward the large number of people who lived in the Pamo village complex.

The cultural resources within the Santa Santa Maria Creek and Ramona Grasslands areas are particularly important to preserve because the sites exist at a landscape scale and the area contains a wide variety of residential, activity-based, and ceremonial archaeological locations. It is extremely rare in California to find an entire settlement complex of villages that can be preserved undisturbed in an intact natural landscape also supporting rare and endangered species."

" Mitigation and conservation Banking generally provides safe harbor for rare and specific sensitive species that occur on the site. The California Environmental Quality Act (CEQA) section 15380.A plant or animal may be treated as rare or endangered even if it has not been placed on an official list when its survival and reproduction in the wild are in immediate jeopardy from one or more causes. Includes loss of habitat, disease, and predation

1755. The Legislature finds and declares all of the following: (a) That it is the policy of this state:: (1) To maintain sufficient populations of all species of wildlife and native plants and the habitat necessary to insure their continued existence at the optimum levels possible to insure the policies stated in paragraphs (2), (3), and (4). (2) To provide for the beneficial use and enjoyment of wildlife and native plants by all citizens of the state.(3) To perpetuate native plants and all species of wildlife for their intrinsic and ecological values, as well as for their direct benefits to man.(4) To provide for aesthetic, educational, and non appropriative uses of the various wildlife and native plant species. (b) That the conservation and enhancement of wildlife species which are not the object of hunting and native plant species is in the general public interest and it is appropriate that the cost of programs to achieve such conservation and enhancement, including thebiological and botanical research necessary thereto, and the diffusion of the information resulting therefrom to the public, be borne to the extent necessary by general public funds.

Respectfully submitted for reconsideration.

Kathleen

From: Kathleen Hayden [redacted] sent: Sunday, **July 6, 2025** 5:37 PM

To: BLM Alex <Aneiberg@ca.blm.gov>; BLM Alexander G Neibergs <aneiberg@blm.gov>; Potter, Andrew <Andrew.Potter@sdcounty.ca.gov>; FGG, Public Comment <PublicComment@sdcounty.ca.gov>

Subject: To BLM Coyote Canyon Heritage Herd HMA Alex_Neibergs@ca.blm.gov

Dear Alex,

Hope all is well with you. Look forward to seeing you sooner than later. We have two new members in the tribe..both a stud colt, Kawi, and a filly, Sable.

Please forward this request to BLM officers and officials to network with San Diego and Riverside counties to re-establish the native Coyote Canyon heritage herd as a Resource in the Resource Management Plans...i.ehttps://www.fws.gov/sites/default/files/documents/FAQ%20San%20Diego%20County%20MSCPsjw%20web_revised.pdf

This recent ruling of 2024 may be critical to the restoration of an HMA for the restoration of the critically endangered Coyote Canyon Herd on the San Diego/Riverside County Multiple Species Conservation Plans.

On March 28, 2024, Judge Du the "federal judge in Reno, Nev., found that U.S. land managers failed to adopt a legal herd management plan or conduct the necessary environmental review before 31 mustangs died during the roundup of more than 2,000 animals in Nevada the previous summer. "The court finds that BLM must be compelled to prepare a herd management area plan (HMAP)," Du wrote in the 29-page ruling issued Thursday sets a precedent that will provide more protection for mustangs going forward. "The court finds that BLM must be compelled to prepare a herd management area plan (HMAP)," ..for the long-term health of the herds and the rangeland in a particular area. "The duty to prepare an HMA arose as soon as the BLM created the HMAs," That duty arose when BLM promulgated the regulation 38 years ago in 1986. BLM's decades-long delays in developing and approving HMAPs have therefore been 'nothing short of egregious' and clearly violate the rule of reason."

Please forward this to appropriate and interested parties. Looking forward to feedback and a long overdue visit. Greetings also from Harley.

Sincerely, Kat

PERSPECTIVES FROM THE FIELD: Wild Horses Are Cultural Resources | Environmental Practice | Cambridge

Original Message -----From: Alex_Neibergs@ca.blm.gov To: Kathleen Hayden Cc: Tom_Pogacnik@blm.gov ; David_Sjaastad@ca.blm.govSent: Friday, **April 11, 2003** 5:24 PMSubject: Re: please send additional info

Hi Kat,

The Decision Record for the Northern and Eastern Colorado Desert and the Northern and Eastern Mojave Desert Coordinated Management Plans was signed in December 2002. These plans included public, local and state agencies, in which the plan addressed a multitude of resource management issues including wild horses and burros. The major emphasis was for the recovery of the threatened and endangered desert tortoise and other federal listed plant and animal species. The outcome changed several HMAs and emphasized that where these animals are to be managed, a herd management area plan would be developed, which would include input from the public, local and state agencies.

We do have Interagency Agreements, Memorandum of Understandings andCooperative Agreements with other land agencies and land owners, which mostly addresses how removals would occur and how the animals would be placed into the National Wild Horse and Burro Adoption Program.

I do have a copy of the California Strategic Plan for Management of Wild Horses and Burros on Public Lands date April 1994. However, many changes have occurred since this time and this document needs to be updated.The coordinated management plans demonstrates a publication for input and partnerships with public/local/and state agencies. However with all the changes brought about to the California Desert District HMAs by the 1994 California Desert Protection Act and the two coordinated management plans,all the herd area management plans (HMAPS) are outdated and **no revised HMAPS have been written.** If you I could provide you copies of any documents mentioned here, please let me know.

Alex

Outlook

Delta Waterfowl Comment Letter

From Christopher Hoon <choon@deltawaterfowl.org>
Date Fri 09/05/2025 10:34 AM
To FGC <FGC@fgc.ca.gov>

Hello,

Please see attached for our comment letter for general public comment for items not on the agenda.

Please let me know if you have any questions.

Thanks,
Chris

Christopher Hoon
Senior Manager of Government Affairs – Pacific Flyway
c: 916-626-7160
e: choon@deltawaterfowl.org

Delta Waterfowl
The Duck Hunters Organization™
DeltaWaterfowl.org

DELTA WATERFOWL
The Duck Hunters Organization™

September 4, 2025

California Fish and Game Commission
715 P Street, 16th floor
Sacramento, 95814.

Dear President Zavaleta and Members of the Fish and Game Commission,

On behalf of Delta Waterfowl members and volunteers in California, thank you for providing us with the opportunity to share public comments about how the California Department of Fish and Wildlife (CDFW), the Commission, and the public interact on issues that impact ducks and duck hunters. Although our organization appreciates the opportunity for specific public comments on refuge-related issues, we believe that the current system could use some improvements to make it a more transparent and thoughtful process for duck hunters and the general public alike.

Currently, the opportunity for public comment occurs in the month of August. We suggest that these meetings be moved up in the year to occur in spring or late summer to allow for more robust discussions on the subject of refuge polices that will impact not only our members, but license buyers across the state. Many individuals feel that the current August meetings are too close to the start of waterfowl seasons, and thus do not allow for a full, thoughtful conversation on these topics. Additionally, many of our members have expressed to me that they feel these meetings do not facilitate genuine discussion; rather, they feel the decisions have already been made by the time the meeting occurs, completely eliminating the public stakeholder process

Delta Waterfowl and our members and volunteers in California would like to offer any assistance to CDFW that we can provide on this issue moving forward. We have chapters across the state and have helped several other state fish and wildlife agencies facilitate similar conversations between public land managers, the agency or commission, and rank-and-file duck hunters. We would be more than happy to do that in California as well.

Please feel free to reach out to me if you have any questions or would like to discuss this further. My email is choon@deltawaterfowl.org.

Sincerely,

Christopher L. Hoon
Manager of Government Affairs – Pacific Flyway
Delta Waterfowl Foundation

Outlook

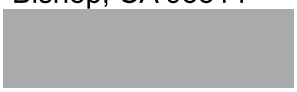
Follow Up letter from Inyo Fish and Wildlife Commission

From gary@bishopflyfishing.com <gary@bishopflyfishing.com>
Date Mon 09/22/2025 01:01 PM
To FGC <FGC@fgc.ca.gov>

Dear Ms. Miller-Henson:

The attached letter if from the Inyo County Fish and Wildlife Commission
To follow up on the Departments progress in addressing mountain lion impact
On local deer and Sierra Nevada Big Horn Sheep populations.

Gary Gunsolley
Bishop Flyfishing Guide Service
4801 Alison Lane
Bishop, CA 93514



INYO COUNTY
FISH AND WILDLIFE COMMISSION
BISHOP, CA 93514

COMMISSION MEMBERS
DOUGLAS BROWN
STEVE IVEY
WARREN ALLSUP
GAYE MUELLER
JARED SMITH

ALTERNATE MEMBER
NICK LARA

REPLY TO:
Pat Gunsolley, Secretary
4801 Alison Lane
Bishop, CA 93514
pgunsolley@gmail.com

July 17, 2025

Ms. Melissa Miller-Henson, Executive Director
California State Fish and Game Commission
P. O. box 944209
Sacramento, CA 94244-20990

Dear Director Miller-Henson

The Inyo County Fish and Wildlife Commission again thanks the State Fish and Game Commission for conducting a meeting in Mammoth Lakes in June02024. At that meeting local concerns were identified with increased mountain lion population impacting the mule deer and Sierra Big Horn sheep populations. Your Commission provided direction to CDF&W on the concerns identified.

The Commission is requesting written updates from both the State Fish and Game Commission and the California Department of Fish and Wildlife on the steps, procedures and policies that have been implemented or are being considered to be implemented as a result of the June 2024 meeting in Mammoth Lakes.

Sincerely,

Doug Brown

Doug Brown, Chairperson

Inyo County Board of Supervisors
Mr. Charlton Bonham, Director California Department of Fish and Wildlife

California Fish and Game Commission
715 P Street, 16th Floor, Sacramento, CA 95814

Sent via: fgc@fgc.ca.gov

RE: Agenda Item 23b

Dear President Zavaleta and Commissioners,

I am writing to provide comments regarding the evaluation of marine protected area (MPA) petitions. My comments focus on two key areas: (1) the need to update the scientific standards for assessing MPA levels of protection (LOP), and (2) concerns regarding the petition evaluation process, specifically the use of historical Marine Life Protection Act (MLPA) criteria. These points are supported by scientific evidence, with clear opportunities to make the best available tools consistent in the state's evaluation of adaptive management processes.

1. Scientific Issues: Need to Update Level of Protection (LOP) Standards

The California Marine Life Protection Act (MLPA) defines **adaptive management** as a policy that "seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning." This approach is codified in the Fish and Game Code § 2852(a), which highlights its role in addressing scientific uncertainty and improving resource management over time, to ensure that the most up to date scientific information is integrated into management decisions. The MLPA defines adaptive management as a dynamic, continuous, learning-centered approach to MPA governance, and therefore scientific knowledge should be integrated to provide updated, meaningful guidance. It is consistent to use the best available science for this adaptive management process.

During the MLPA process, the Scientific Advisory Team developed the 2009 Level of Protection (LOP) evaluation framework used to assess the degree to which an area is protected. This document reflected the best available science at the time but is now outdated, as over 15 years have passed since its development. Scientific advancements that integrate changing ocean conditions necessitate a shift toward contemporary frameworks. Key issues with the 2009 LOP standard include:

A. **Failure to Account for High-Impact Gear Types**: Gear types such as purse seine and bottom trawlers are now scientifically recognized as high-impact due to their bycatch rates and habitat disruption[1][2]. The 2009 standard does not adequately address these impacts, leading to the misclassification of MPAs that allow such activities.

[1] https://cdnsciencepub.com/doi/full/10.1139/cjfas-2023-0094

[2] https://www.sciencedirect.com/science/article/pii/B9780323885393000182?__cf_chl_rt_tk=U80mSWP5bSvwYCYiVrxDcAh3H6kZFDgxzuNw7yaXPYE-1758757962-1.0.1.1-zLx5VX6j4iNBypD8SZ_q7uM7t.p6DW_hVMf_wnBCWUg

B. **Risk to Endangered Species**: MPAs rated as having high LOP under the 2009 standard may still allow activities that jeopardize endangered species. The status of species as either threatened or endangered has changed since 2009. For instance, salmonids and steelhead populations have been listed as threatened or endangered since 2009 and white sea bass commercial fisheries were shut down; whereas other species such as rockfish have increased in abundance. In addition, species shifts occurring due to climate change also need to be integrated into current management of MPAs. Failure to update and consider the status of threatened and endangered species today contradicts the core objective of MPAs to protect biodiversity and support ecosystem recovery.

C. **Flawed Assumptions in Fishing Impact Assessments**: The 2009 standard erroneously assumes recreational fishing has infinite impact because fishing licenses are unlimited. In this instance, the MPA is assigned a lower level of protection. However, this logic was inconsistently applied, as other gear types with potential for infinite bycatch mortality (e.g., purse seine gear) were not evaluated under the same premise. The amount of bycatch could then be infinite– this inconsistency undermines the ecological validity of the standard. This assumption also fails to consider the true intensity of local shore-based fishing.

The Best Available MPA Evaluative Framework: The MPA Guide

Published in the prestigious journal *Science* in 2021[3], The MPA Guide is now the leading science-based framework for classifying Marine Protected Areas (MPAs) and predicting their outcomes[4]. Its credibility is demonstrated by its rapid adoption; it has been cited over 400 times and applied as a standardized tool in at least 13 scientific studies across diverse regions. Designed for international use by local experts, its relevance is further confirmed by its adoption by the Ocean Protection Council for California's 30x30 conservation roadmap

The MPA Guide is more scientifically rigorous than the 2009 framework particularly:

- **Gear-Type Specificity**: The *MPA Guide* categorizes fishing gear based on impact, with "green" gear types (e.g., single hook-and-line) classified as low-impact and selective. MPAs allowing only such gear types are deemed "highly protected", if there is low intensity use; however a lack of data for fish catch limits the ability to effectively track intensity.

- **Recreational Fishing Classification**: For example, MPAs that allow only recreational, shore-based fishing using hook-and-line (a single green gear type) qualify as highly protected areas under the *MPA Guide*. This contrasts with the 2009 standard, which may have undervalued such MPAs.

[3] https://www.science.org/doi/abs/10.1126/science.abf0861
[4] https://www.sciencedirect.com/science/article/pii/S0308597X24003622

- **Outcome-Based Framework**: The *MPA Guide* connects MPA types to expected ecological outcomes, ensuring that protections are scientifically grounded and practical.

Given these advancements, continuing to use the 2009 LOP standard risks misclassifying MPAs and undermining California's conservation goals. I urge the FGC to formally adopt the *MPA Guide* as the primary framework for evaluating MPA petitions.

2. Petition Evaluation Process Issues

The process for evaluating MPA petitions has lacked transparency, particularly regarding the use of historical MLPA LOP standards. Key concerns include:

- **Unclear Guidance on Evaluation Criteria**: While the California Fish and Game Commission (FGC) encouraged petitioners to familiarize themselves with historical MLPA processes, it was never explicitly stated that the exact 2009 LOP criteria would be used to evaluate petitions. The FGC's October 2023 guidance stated that petitioners were "encouraged, but not required" to understand historical contexts, implying that adherence to historical standards was not mandatory for petition success. Moreover, despite the Roadmap to 30x30 utilizing the MPA Guide, the SeaSketch tool developed by OPC staff analyzes protected areas by the 2009 guidance, representing an inconsistency between state management standards and an opportunity to improve inter-agency communication.

- **Inaccessible Historical Documents**: For the South Coast region, the MLPA LOP guidance was not publicly available during petition drafting. Although Appendix R of the 2008 Master Plan Appendices referenced South Coast criteria, it stated, "To be added upon region completion," and this document was never published. While CDFW offered access upon request, petitioners were not aware of which documents were critical, leading to unintended omissions in petition designs.

- **Procedural Inequity**: Basing evaluations on undisclosed or inaccessible historical criteria creates an uneven playing field. Petitioners who were unaware of the specific 2009 regional LOP standards could not tailor their proposals to meet these criteria, potentially disadvantageously evaluating scientifically sound petitions.

To ensure fairness and transparency, I recommend:

- Publicly releasing all historical MLPA documents, including region-specific LOP criteria and methodology.
- Clarifying evaluation criteria upfront, ideally transitioning to the *MPA Guide* framework.
- Providing clear guidance on how historical contexts will be integrated into future evaluations.

3. Conclusion and Recommendations

California's leadership in marine conservation depends on using the best available science and ensuring equitable processes across agencies. To align with these principles, we urge the FGC to:

1. **Consider using the *MPA Guide* as the primary standard** for evaluating MPA levels of protection, replacing the outdated 2009 LOP criteria. At a minimum, CDFW and FGC should compare LOP results from the 2009 LOP evaluation framework to the results the MPA Guide yields for the petitions that are before the Commission.
2. **Ensure transparency in the petition evaluation process** by making all historical documents publicly available and clearly communicating evaluation criteria.
3. **Align MPA evaluations with contemporary conservation goals**, particularly the 30x30 initiative, to maximize ecological outcomes and social equity. The MLPA Master Plan states that "objectives must be evaluated in the context of changing ocean conditions and multiple ocean threats, such as climate change, fishing pressure, water quality degradation, marine debris, invasive species, and other existing and emerging issues. Traditional understanding and the components of ecosystem structure (i.e., species and functional groupings) and function (i.e., ecological interactions) may change significantly in the future. Evaluating the effectiveness of the MPA network at achieving the management objectives will need to account for this reality."

The evaluation of California's Marine Protected Area (MPA) Network is critically important precisely because it does not exist in a static environment. The California ocean is undergoing rapid and profound changes, driven primarily by climate change, which is causing ocean acidification, warming waters, and deoxygenation. These foundational shifts amplify other persistent threats, including fishing pressure, water quality degradation from runoff and pollution, marine debris, and the potential for invasive species. A static MPA network, designed for past conditions, risks becoming ineffective if its goals and management are not adapted to this new reality. Therefore, a comprehensive evaluation is essential to assess whether the MPAs are building resilience to these cumulative stressors, to identify which threats are most impacting biodiversity, and to guide adaptive management strategies that ensure the network can fulfill its conservation objectives in the face of both existing and emerging ocean challenges.

Thank you for considering these comments. I appreciate the California Fish and Game Commission's commitment to science-based decision-making and welcome further dialogue on these critical issues.

Sincerely,
Rikki Eriksen, Ph.D.
California Marine Sanctuary Foundation

Outlook

Sen. Kennedy Discusses DEI In Elite Universities with Asst. AG Dhillon

From paul weakland <[redacted]>
Date Sun 08/10/2025 08:35 AM
To FGC <FGC@fgc.ca.gov>

https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fyoutu.be%2F2GLh-KC2LeQ%3Fsi%3D2QyJhzQOC22g9aiD&data=05%7C02%7CFGC%40fgc.ca.gov%7C4ff86553e70f44d19caf08ddd82387f4%7C4b633c25efbf40069f1507442ba7aa0b%7C0%7C0%7C638904369302558652%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=8%2B%2BdsaaiCE7BCFOcuGYgaP5VKOYofRastxrV8IVRShE%3D&reserved=0

Sent from my iPad

Outlook

Offshore wind turbines destroying Britain's fishing trade

From mbcfo member <mbcfo1972@gmail.com>
Date Tue 08/12/2025 08:15 AM
To [redacted]

Tom Hafer
Secretary MBCFO
[redacted]
mbcfo1972@gmail.com

The offshore wind turbines destroying Britain's fishing trade

Sat, August 9, 2025 at 4:00 AM PDT

The shallow waters that are ideal for fishing are also perfect for wind turbines - jokuephotography/iStockphoto

When Ken Bagley led a convoy of fishing boats into battle against the UK's first wind developers two decades ago, his hope was to save something of the fishing industry that had supported his family since the 1890s.

Bagley's convoy sailed in front of the barges attempting to

install the first turbines in the rich fishing grounds off Skegness, halting work and infuriating the contractors trying to kick-start Britain's entry into the world of green energy.

"They were installing that turbine into one of the richest mussel beds in the region, so I led 22 boats into the construction area and halted the work. We thought it was a great victory back then," recalls Bagley, who is chairman of the Boston Fishermen's Association.

Twenty years later, he sees it as a hollow victory: "The wind farms are still stealing our fishing grounds from us."

Now aged 84, Bagley still fishes out of Boston harbour in Lincolnshire – as did his father and grandfather. His son and three nephews have followed their forefathers, each with their own boats.

But where he used to steam daily up to the fishing grounds north of the Wash, hunting for cod, sole and whiting, he now motors out, waits for low tide and then hand-rakes the sand for cockles and other shellfish in the areas so far untouched by wind farms.

"We can't go into the areas between the turbines," he says. "If we towed our fishing gear through a wind farm we'd be snagging on something in no time. And with the tidal currents and winds we get round there it'd get really

dangerous."

Around Britain's coast other fishermen tell similar stories of exclusion from fishing grounds where they and their forebears once reaped rich harvests.

Their problem is that the same relatively shallow waters that are ideal for finding fish are also perfect for turbines – and the wind farm developers are taking over. In theory, fishermen are still allowed to fish between the turbines, but the threat of snagging or collision means few do.

Back in the early 2000s there were only a handful of turbines in UK waters – the first two arrived in 2000 off the coast of Blyth in Northumberland.

Since then, about 3,000 of the giant machines have been installed across nearly 50 wind farms that now cover thousands of square kilometres of ocean. The largest so far is Hornsea 2, which covers 462 square kilometres of the North Sea.

Far larger ones are on the way: Dogger Bank, a joint venture between Equinor, Vårgrønn – both Norwegian – and SSE, is being built across a shallow area of the North Sea once among Europe's richest fishing grounds. It will cover around 1,300 square kilometres once complete.

Construction is already destroying the local fishing industry, says James Cole, who fishes out of Whitby in Yorkshire. He's head of the Whitby Commercial Fishermen's Organisation.

"The cables being laid from Dogger Bank plus the carbon capture pipelines that are also being laid out to sea are hugely disruptive," he says. "We can't fish in areas where they are working but this is the crab and lobster season, which is the time when we earn most of our income.

"These foreign wind companies are just forcing British fishermen to move away from their traditional fishing grounds. We are being pushed around by big business and useless politicians."

Dogger Bank is, however, just a fraction of what is to come. The UK's 3,000 offshore turbines have a capacity of about 16 gigawatts – but last week Ed Miliband, the Energy Secretary, confirmed plans to triple that capacity by 2030 with even more by 2050.

It means thousands more turbines, collectively driving Britain's fishermen into ever smaller areas.

Livelihoods ‘under threat’

Mike Roach, deputy chief executive of the National Federation of Fishermen’s Organisations, says: “The greatest impact of offshore wind on fishing is displacement. There is an assumption that fisheries are infinitely relocatable, but the fish species we target do not exist everywhere.”

If wind turbines built on the seabed are a threat, then the floating wind farms now being deployed will be a far bigger disaster for fishermen according to experts. Such machines are designed for waters too deep for conventional turbines. In theory they offer a way to encircle the entire British Isles with wind farms – with official maps showing planned construction already approaching this level.

Elspeth Macdonald, chief executive of the Scottish Fishermen’s Federation, says each floating turbine will need to trail multiple mooring and power cables down the water column and between machines.

“These structures will be anchored to the seabed with complex and extensive subsurface infrastructure, which will make it impossible for mobile fishing gear – trawls et cetera – to fish within the windfarms,” Macdonald says.

“Fishing will be displaced to areas that are less productive, and there will be greater competition for space to fish.”

A study by Plymouth Marine Laboratory (PML) published in March found that the majority of UK fishermen feel their livelihoods are being threatened by the rapid expansion of offshore wind, with the impact felt across all vessel sizes and fleet sectors.

The key impacts included being pushed out of traditional fishing grounds, damage to nets and other gear from subsea cables, and the destruction of seabed habitats vital to their target species.

“Fishermen across all fleet sectors are experiencing social, wellbeing, and economic impacts from offshore wind developments,” says PML researcher Claire Szostek.

“While a small minority identified potential benefits, most fishermen feel their fishing grounds and livelihoods are under threat.”

The economics of the two industries show why fishermen are struggling to be heard.

The UK fishing industry, with 4,269 active vessels and employing over 6,800 fishermen in 2021, generated a

turnover of £802m and a profit of £222m, the PML study found.

That means it is already dwarfed by offshore wind, with trade body RenewableUK claiming the industry employs 55,000 people – and that number is set to increase.

Such claims need to be treated with caution. Many of the jobs reported by RenewableUK will be temporary, linked to initial construction of wind farms, so once they are built some jobs are likely to fall away.

Szostek emphasises that while offshore wind may exceed fisheries in monetary value, these figures omit the cultural heritage value of fisheries, which are vital to many coastal communities and important in fisheries policy development.

Politicians ‘know nothing’

Stuart King, of West Coast Sea Products, based in Kirkcudbright, Scotland, runs five scallop fishing boats that operate around UK coasts, generating jobs for 135 people including 35 crew.

He points out that the UK’s fisheries minister, Daniel Zeichner, represents landlocked Cambridge. Zeichner’s boss is Steve Reed, the Environment Secretary – who is MP for Streatham and Croydon North in south London, also far from

the sea.

“Our politicians are making decisions about fishing based on nothing more than watching a David Attenborough documentary,” King says. “They know nothing. Not only are we excluded from wind farms but there is a growing hazard from the cables taking power ashore. These are often covered in rocks and if we snag them it’s a serious safety hazard. These cables are closing off large areas of our fishing grounds.”

RenewableUK rejects such claims. Ana Musat, its policy director, said offshore developers worked collaboratively with the fishing industry to ensure fishing could continue.

“Offshore wind farms are specifically designed to enable coexistence,” she says. “Where there are temporary disruptions to fishing, for example due to construction safety requirements, developers provide cooperation payments for loss of earnings.

“Offshore wind developers are always willing to listen and take on feedback.”

One of the least expected problems could turn out to be among the most important. The massive armoured cables laid from wind farms to convey their power back to shore are not just a problem for fishermen, but potentially also for marine species.

That’s because, in the total darkness of the sea floor, many species rely on the Earth’s magnetic field to navigate – but the powerful electrical currents passing through the cables generate far stronger fields.

Scientists have reported some species like crabs becoming mesmerised, while some fish larvae become less active.

Some fishermen see that as a metaphor for the behaviour of politicians, so obsessed with climate change and cutting emissions that they are destroying one of the most traditional of British industries.

Bagley said: “We are just being pushed out. We have to ask: where are we going to be able to fish? Everything is being taken off us.”

A government spokesman said: “We are working closely with the Crown Estate to ensure the seabed is strategically unlocked for offshore wind, while minimising impact on fishing.

“We are supporting the next generation of fishers with our £360m Fisheries and Coastal Growth Fund, alongside bringing thousands of skilled jobs to coastal towns through offshore wind projects.”

Outlook

Fwd: Geophysical seismic surveys off Central California to study Cross-Hosgri fault.

From mbcfo member <mbcfo1972@gmail.com>
Date Tue 08/19/2025 06:49 AM
To FGC <FGC@fgc.ca.gov>
Cc Miller-Henson, Melissa [redacted]>

Dear California Fish and Wildlife,

Are you aware of this study? Did DFW approve it?

Tom Hafer
Secretary MBCFO
[redacted]
mbcfo1972@gmail.com

Begin forwarded message:

From: mbcfo member <mbcfo1972@gmail.com>
Subject: Geophysical seismic surveys off Central California to study Cross-Hosgri fault.
Date: August 18, 2025 at 4:55:22 PM PDT
To: gcochrane@usgs.gov, sjohnson@usgs.gov, ngolden@usgs.gov
Cc: Alan Alward <[redacted]>, Bill Blue <[redacted]>, Owen Hackleman <[redacted]>, Tom Hafer <somethingsfishy@charter.net>, Bob Maharry <[redacted]>, Matt Newman <[redacted]>, Jeremiah O'Brien <[redacted]>, Garrett Rose <[redacted]>, Mark Tognazzini <[redacted]>

Dear USGS,

We represent ~ 100 commercial fishermen out of Morro Bay, California. We recently found out that USGS will be doing a seismic testing project off the Central Coast (discussed below). This same type of seismic testing was requested by PG&E in 2013 and was not permitted by the Coastal Commission in 2013.

What has changed? Was this project permitted by the Coastal Commission? Did Fish and Wildlife approve this project? This could impact commercial fishermen's catches for days to years. See attached study of impacts to fish, eggs, larvae from high decibel noise. What decibels will be used with the Chirp 516? The specs don't show dBs. If it penetrates 250 m. It must be loud! What mitigation has been developed? Why are we finding out about this 2nd hand less than 30 days before the project?

TABLE 2 Proposed interim criteria for mortality and recoverable injury from exposure to pile 1.2 s intervals (Halvorsen et al., 2012b, 2012c). Temporary threshold shift (TTS) based on Pop both for mortality and recoverable injury since the same sound exposure level (SEL_{ss}) was use presented as sound pressure even for fishes without swim bladders since no data for particle given for animals at three distances from the source defined in relative terms: N, near; I, inter

Type of Animal	Mortality and potential mortal injury	Recoverable injury	Im
Fish: no swim bladder (particle motion detection)	> 219 dB SEL_{cum} or > 213 dB peak	> 216 dB SEL_{cum} or > 213 dB peak	>>
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{cum} or > 207 dB peak	203 dB SEL_{cum} or > 207 dB peak	> 1
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{cum} or > 207 dB peak	203 dB SEL_{cum} or > 207 dB peak	18
Sea turtles	210 dB SEL_{cum} or > 207 dB peak	(N) High (I) Low (F) Low	(N) (I) (F)
Eggs and larvae	> 210 dB SEL_{cum} or >207 dB peak	(N) Moderate (I) Low (F) Low	(N) (I) (F)

Peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 $\mu Pa^2\ s^{-1}$.

We hope you are taking time to consider the people whose livelihoods depend on healthy sustainable fisheries before going forward with this project,

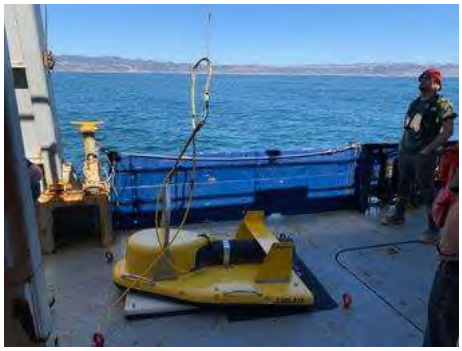
Tom Hafer
Secretary Morro Bay Commercial Fishermen's Organization

Here is a **brief overview of their project**:

"Geophysical surveys aboard the **R/V Parke Snavely** offshore central CA in order to image sediments cut by a series of faults. The goal is to determine Holocene activity on the faults and target specific regions for possible paleoseismic studies. Also, target the Cross Hosgri Slope in order to generate a pseudo 3D map of the sediment drape to evaluate the difference in offset measured at the seafloor vs the buried shoreface feature. Additional targets will be focused on small transtensional pull-apart basins along the Hosgri Fault, and shallow channels imaged offshore Point Sal, which could potentially provide a Holocene slip rate. This work will help provide earthquake hazard analysis to the central CA coast, which hosts the Diablo Canyon Nuclear Power Plant."

https://www.usgs.gov/centers/pcmsc/science/chirp-516

Overview of the survey equiptment:



- A sub-bottom profiler like the EdgeTech SB-516 Chirp emits acoustic pulses to produce an image of the layers of sediment below the seafloor.
    - The EdgeTech SB-516, or "Chirp," is a sub-bottom profiler. The Chirp produces frequency-modulated acoustic pulses in the 0.5-16 kHz range and records their reflections to create two-dimensional images (cross-sections or "profiles") of the sediment layers beneath the seafloor. See the gray illustration below for an example. The Chirp's acoustic penetration can range from 40-250 m, and vertical resolution can be as good as 6 cm, depending on factors such as sediment type and sea state. The system consists of a **tow vehicle (fish)** that has both transmit and receive arrays, as well as the electronics to interface with the sonar and convert between analog and digital signals, a 100 m data cable, and a deck unit with a PC and the Starmux III Digital Telemetry Link.

Operational Characteristics

- Minimum Operational Depth: 3 m (with use of cataraft)
- Maximum Operational Depth: 2000 m
- Tow Height: 3-5 m above sea floor OR 15 m or greater below sea surface
- Sediment Type: Any, penetration will vary from 40 m in coarse sand to 250 m in clays
- Limitations: Tow height of the fish is limited by the length of data cable (100 m). On large vessels the topside unit must be located sufficiently close to the tow point of the fish that the there is enough data cable to reach desired tow depth.
- Power Outputs / Frequency Ranges 2000 W, 0.5 – 16 kHz
- Ship's Requirements
    - Winch and over-boarding gear with 2000lb SWL
    - Can be deployed with A-frame, davit, j-frame, with one block for winch line
    - 1 person must be able to stand sufficiently close to the wire during deployment to marry the data cable to the tow cable with zip ties
    - 62"x53" footprint

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JOURNAL OF FISH BIOLOGY fsbi

REVIEW PAPER

An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes*

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[2]Loughine Ltd., Aberdeen, UK

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Fishes use a variety of sensory systems to learn about their environments and to communicate. Of the various senses, hearing plays a particularly important role for fishes in providing information, often from great distances, from all around these animals. This information is in all three spatial dimensions, often overcoming the limitations of other senses such as vision, touch, taste and smell. Sound is used for communication between fishes, mating behaviour, the detection of prey and predators, orientation and migration and habitat selection. Thus, anything that interferes with the ability of a fish to detect and respond to biologically relevant sounds can decrease survival and fitness of individuals and populations.

Since the onset of the Industrial Revolution, there has been a growing increase in the noise that humans put into the water. These anthropogenic sounds are from a wide range of sources that include shipping, sonars, construction activities (*e.g.*, wind farms, harbours), trawling, dredging and exploration for oil and gas. Anthropogenic sounds may be sufficiently intense to result in death or mortal injury. However, anthropogenic sounds at lower levels may result in temporary hearing impairment, physiological changes including stress effects, changes in behaviour or the masking of biologically important sounds.

The intent of this paper is to review the potential effects of anthropogenic sounds upon fishes, the potential consequences for populations and ecosystems and the need to develop sound exposure criteria and relevant regulations. However, assuming that many readers may not have a background in fish bioacoustics, the paper first provides information on underwater acoustics, with a focus on introducing the very important concept of particle motion, the primary acoustic stimulus for all fishes, including elasmobranchs. The paper then provides background material on fish hearing, sound production and acoustic behaviour. This is followed by an overview of what is known about effects of anthropogenic sounds on fishes and considers the current guidelines and criteria being used world-wide to assess potential effects on fishes.

Most importantly, the paper provides the most complete summary of the effects of anthropogenic noise on fishes to date. It is also made clear that there are currently so many information gaps that it is almost impossible to reach clear conclusions on the nature and levels of anthropogenic sounds that have potential to cause changes in animal behaviour, or even result in physical harm. Further research is required on the responses of a range of fish species to different sound sources, under different conditions. There is a need both to examine the immediate effects of sound exposure and the longer-term effects, in terms of fitness and likely impacts upon populations.

KEYWORDS

behaviour, criteria, effects, guidelines, hearing, sound

*This paper is dedicated to two long-time friends and colleagues, Colin Chapman and Richard R. Fay. Colin and Dick have been major contributors to our understanding of fish bioacoustics. Moreover, their work and their thinking has inspired many of the studies described in this review.

1 | INTRODUCTION

The past several decades have seen an increasing level of interest in the potential effects of anthropogenic sounds on aquatic life. The sounds added by humans into aquatic environments (both marine and freshwater), include those from shipping, dredging, sonars, seismic airguns used for oil and gas exploration, underwater explosions and construction, including pile driving, as well as many other activities. Anthropogenic sounds such as these have increased in recent times as a result of increases in shipping, harbour developments, the construction and operation of offshore wind farms, tidal and wave energy generation, dredging and cable and pipe laying, seismic surveys for oil and gas and offshore oil developments. Although initial concern regarding anthropogenic sound focussed on the effects upon marine mammals (NMFS, 2018; NRC, 1994; Southall *et al*., 2007), there is now growing concern over potential effects upon those organisms that make up a much larger part of the aquatic biomass, fishes and more recently, invertebrates and zooplankton (Popper & Hawkins, 2016). Concern has also been expressed recently over effects upon freshwater fishes (Bolgan *et al*., 2016; Mickle & Higgs, 2018), since they have received far less attention in research on noise effects studies.

The added sounds in the aquatic environment may have a wide range of effects on fishes. Exposure to very intense sounds may result in mortal injuries, but far more important issues are associated with sounds that are detectable by fishes and which may affect their behaviour, causing them to move away from their migration routes, leave favoured habitats in which they feed or breed, interfere with communication using sound, affect reproductive behaviour (where sound is used to attract mates and facilitate spawning), or prevent the detection of other biologically important sounds. As a consequence, the addition of anthropogenic sounds to the aquatic environment has the potential to do significant harm to fishes.

From an historical perspective, fish bioacoustic studies up until the early 21st century asked basic questions about hearing, sound communication and behaviour. While such studies continue, many studies since about 2005 have focussed on the potential adverse effects of sounds on fishes. A driving force in this change has been the need by regulators, industry, environmental groups and scientists to develop guidelines and criteria that can be used to assess whether particular sounds have deleterious effects on individual fishes or affect populations. There has also been a need to employ such information in regulations intended to protect fishes and ecosystems.

2 | OVERVIEW

The purpose of this paper is to improve understanding of the issues related to the potential effects of anthropogenic sounds on fishes and to point to the need to examine effects not only on individual animals, but also to those on fish populations and ecosystems. However, since many readers may not be familiar with fish bioacoustics, we also include some background material to assist readers in understanding and interpreting data on the effects of anthropogenic sound. Accordingly, the paper starts with a brief discussion of underwater sound in order to introduce major concepts that are critical for understanding potential effects of anthropogenic sound. This is followed by a discussion of fish bioacoustics for those not familiar with the topic. We then focus on data on the potential effects of anthropogenic sound on fishes. It will become clear that there are major gaps in our knowledge that need to be filled in order to facilitate the development of appropriate and effective sound exposure criteria and the guidelines to implement them. Indeed, it is critical to understand that current criteria are still provisional and that substantially more data are required before firm criteria can be set. The review therefore ends with suggestions as to the most critical current data needs.

This paper is not intended to be a complete review of all the literature. Rather, our focus is on the major issues related to potential effects of anthropogenic sound on fishes and to help readers understand those aspects that are especially important. However, we do provide further citations so that those interested can delve deeper into the growing literature on the topic and we include a number of recent reviews that refer to the wider literature. Furthermore, the papers we do include are those we think are amongst the most informative and critical to understanding the main issues. At the same time, we do include a number of papers that we see as being problematic, so that as well as providing insight into work that is critical to understanding the effects of sound on fishes, we also provide information on work that may lead to misunderstanding.

3 | ADDITIONAL BACKGROUND INFORMATION

For those interested in broadening their understanding of general issues of fish bioacoustics (hearing, sound production, behaviour *etc.*), there are papers in a volume by Webb *et al*. (2008) as well as several more recent reviews (Ladich, 2014; Ladich & Fay, 2013; Mickle & Higgs, 2018; Putland *et al*., 2018). More detailed reviews of potential effects of anthropogenic sound on fishes (and other aquatic animals) can be found in papers by the authors of this review (Hawkins *et al*., 2015; Hawkins & Popper, 2014; Popper & Hawkins, 2018) and in the reports of several meetings on the *Effects of Noise on Aquatic Life* (www.an-2019.org; Hawkins *et al*., 2008; Popper & Hawkins, 2012, 2016 and the open access *Proceedings of Meetings on Acoustics* (www.go.umd.edu/UcA). Finally, a general overview of effects of anthropogenic sound on animals is provided by Slabbekoorn *et al*. (2018).

4 | THE IMPORTANCE OF HEARING

Of all the senses, hearing provides fishes with information, often from great distances, in the widest variety of environments, by day and night and from all directions around the animal. The limitations of other senses such as vision, touch, taste and smell in the aquatic environment, particularly in providing rapid, long-distance and 3-D information, make sound an exceptionally important cue for many (perhaps most) aquatic animals.

Detection of the acoustic scene (often referred to as the soundscape), which is the ensemble of ambient sound, including sound

events, associated with a specific location at a particular time, is found in all vertebrates (Bregman, 1994; Fay, 2009; Slabbekoorn, 2018). Indeed, many of the most important aspects of hearing are likely to have evolved to enhance analysis of the soundscape. For example, the ability to determine the direction of a sound (sound source localisation) enables fishes (and other vertebrates) to locate predators and move away from them or detect potential prey and move towards them (Hawkins & Popper, 2018; Sand & Bleckmann, 2008). Likewise, the ability to discriminate between different sounds enables fishes to tell friend from foe or recognise and select members of their own species for mating. Once hearing evolved in fishes, acoustic communication became possible. However, while sound production is found in some fishes, many, including some that hear very well (*e.g.*, many otophysans), do not produce sounds. Instead, these species use hearing primarily for detection of those natural sounds that make up the acoustic scene. Because of the importance of sound to fishes, it becomes clear that any interference with detecting the acoustic scene or with those sounds used by some fishes to communicate, has the potential to affect fitness and survival!

5 | UNDERWATER SOUND

While the basic physics of sound in water are similar to those in air, the density of the medium is greater and as a result sound travels about 4.8 times faster than in air (1500 m s^{-1} *v.* 343 m s^{-1}). As a result, a 100 Hz sound has a wavelength of 3.43 m in air, but it is 15 m in water (see www.dosits.org for an excellent primer on underwater sound). While we do not go into underwater acoustics in any detail, a number of terms and ideas are presented since they are critical to understanding fish bioacoustics and the analysis of sounds that have the potential to affect fishes.

5.1 | Acoustic terminology

It is important to distinguish between sound and vibration. Sound is generated by the movement of an object, such as a loudspeaker, or a pile being driven, in a medium such as air or water (Urick, 1983). The term vibration refers to the actual motion of the sound source. As the sound propagates from the source it can be detected as the pressure fluctuations in the medium, above and below the local hydrostatic pressure (the sound pressure). However, sound is also accompanied by a back-and-forth motion of the medium, referred to as the particle motion. (For a clear visualisation of sound pressure and particle motion see: www.dosits.org/science/sound/what-is-sound/).

The term noise is often used to describe unwanted sounds that are considered to be unpleasant, loud or disruptive to hearing, or that can hinder detection of a particular signal. In some cases, however, the terms ambient noise or background noise may also be used, as it is in this paper, to describe sound generated by natural sources, as well as by anthropogenic sources, especially where they may interfere with the detection of animal and other sounds.

5.2 | Sound pressure, particle motion and the substrate

Sound pressure is a scalar quantity that acts in all directions. It can be described in terms of its magnitude, as well as its temporal and frequency characteristics. In contrast, particle motion is a back-and-forth motion and, as such, is a vector quantity. Accordingly, particle motion is described not only by specifying its magnitude and temporal and frequency characteristics, but also its direction of motion.

Sound pressure is expressed in SI units of pascals (Pa) or micropascals (μPa). Particle motion may be expressed in terms of the particle displacement (SI unit: metre m), or its time derivatives: particle velocity (meter per second m s^{-1}) or particle acceleration (meter per second squared (m/s^2). Sound intensity is the product of the sound pressure and the particle velocity, for which the SI units are watts m^{-2}.

A fundamental point is that all fishes (including elasmobranchs) detect and use particle motion, particularly at frequencies below several hundred Hz (Nedelec *et al.*, 2016; Popper & Hawkins, 2018). Thus, the detection of particle motion is integral to hearing in all fishes (and invertebrates) and it is used to locate the direction of the source, even in those fishes that are also sensitive to sound pressure (Hawkins *et al.*, 2015; Nedelec *et al.*, 2016). As a consequence, when investigating the effects of sounds upon fishes, it is important to describe the sounds in terms of particle motion (Popper & Hawkins, 2018), as well as sound pressure. This may be done by measuring the particle motion directly (Amorim *et al.*, 2018; Mickle *et al.*, 2018; Roberts & Breithaupt, 2016) or by conducting experiments under free-field acoustic conditions, where the particle motion can be predicted from measurements of the sound pressure (Hawkins *et al.*, 2014). Until recently, most studies of sound and fishes have only included measurement of the sound pressure and very few have considered particle motion in a biologically relevant context. This was not just because investigators did not fully appreciate the importance of particle motion, but also because of the difficulty in obtaining instrumentation to measure the particle motion (*e.g.*, Lumsdon *et al.*, 2018; Martin *et al.*, 2016).

While it is possible to estimate particle velocity from measurements of the sound pressure (or by measuring the pressure gradient), this can only be done in locales that are distant from reflecting boundaries (the water surface or bottom) or other acoustic discontinuities (MacGillivray *et al.*, 2004), since such surfaces have significant influence on the sound field and thus, on the levels and directionality of particle motion. Under such conditions, sensors are needed that not only detect particle motion (whether particle displacement or its time derivatives: particle velocity or particle acceleration) *per se* but are also able to detect the vector components in three dimensions.

Passage of sound and vibration into the substrate, which can be caused by sources such as pile driving, dredging and seismic surveys, may result in waves propagating through the substrate, both as compression waves and interface waves (Popper & Hawkins, 2018). The interface waves are often referred to as ground roll (Hazelwood *et al.*, 2018). These waves travel slower than the speed of sound and can have strong particle motion components. They may also generate

evanescent sound pressure and particle motion waves that propagate through the water.

5.3 | Sound metrics

It is very important to always refer to a sound using the proper measures, or metrics, that best describes that sound.

5.3.1 | Continuous sound

Continuous sound (*e.g.*, from shipping) is generally presented as the root mean square (dB_{rms}) sound pressure or particle motion level, measured over a specified time interval, for a specified frequency range. The roughness of continuous sounds may be especially important when considering effects, using a statistic often called kurtosis (Henderson & Hamernik, 2012). However, while of potential importance, and while mentioned more and more frequently, kurtosis has yet to be applied to fish (or marine mammal) bioacoustics.

5.3.2 | Impulsive sounds

Impulsive sounds (*e.g.*, from pile driving) are best presented as the instantaneous peak level, the dB_{peak}. That is, the level of the zero-to-peak sound pressure or particle motion. Alternatively, the total energy within the pulse may be described by the sound exposure level (SEL; Popper & Hastings, 2009). The SEL is the integral, over time, of the squared sound pressure, normalised to a reference time of 1 s. The SI unit of sound exposure is the Pascal squared for 1 s ($Pa^2\ s^{-1}$). The SEL may be specified for a single impulse or strike (the SEL_{ss}). However, when impulsive sounds are repeated, for example when fishes are exposed to pile driving for a long period, it is appropriate to estimate the cumulative SEL (SEL_{cum}) associated with a series of pile strikes. The SEL_{cum} is the total noise energy to which the animal is exposed over a defined time period (Popper & Hastings, 2009).

Another important characteristic of impulsive sounds is the rise time, which is the time a signal takes to increase from 10% to 90% of its highest peak value. The rise time may affect the response of animals and may be especially important in terms of injury, where sharp rise times may be especially damaging.

5.3.3 | Frequency spectrum

The frequency spectrum is also important. The sound pulse is composed of a range of frequencies, expressed in terms of the level at each frequency measured over a given bandwidth. The bandwidths utilised are generally 1 Hz or $^1/_3$ octave (an octave is a doubling of frequency). It is important to specify the frequency bandwidth as different animals respond to different frequency ranges.

6 | NATURAL SOUNDS IN THE AQUATIC ENVIRONMENT

6.1 | Ambient sound

Aquatic environments are rarely silent. Ambient sound (often termed ambient noise) consists of sounds generated by physical sources such as wind, waves, precipitation and ground movement (geophony), together with biotic sounds (biophony) produced by a variety of marine organisms, including mammals, fishes and invertebrates. Examining the soundscape involves describing the characterisation of ambient sound in terms of its spatial, temporal and frequency attributes and the types of sources contributing to the sound field.

6.2 | Fish sounds

Of the more than 33,000 species of fish, at least 800, from over 100 families, are known to produce sounds (Bass & Ladich, 2008). It is likely that with more studies, including freshwater fishes, many additional species will be shown to be sound producers. Many commercially important fish species produce sounds, including the Atlantic cod, *Gadus morhua* L. 1758 and haddock, *Melanogrammus aeglefinus* (L. 1758), both Gadidae (Hawkins *et al.*, 1974; Hawkins & Chapman, 1966) and many croakers and drums (Sciaenidae; Ramcharitar *et al.*, 2006). Sounds are produced in a wide range of contexts such as feeding, mating, or fighting (Hawkins & Myrberg Jr, 1983; Moulton, 1963). The detection of sounds may be used by female fishes to locate vocal males and identify suitable mates (Casaretto *et al.*, 2015). As a consequence, anything, including sounds from anthropogenic sources, that impedes the detection of these sounds can have an adverse effect on such fishes.

7 | ANTHROPOGENIC SOUND SOURCES

There are many sources of anthropogenic sound in the sea, lakes and rivers, with quite different acoustical characteristics (Hawkins *et al.*, 2015; Popper *et al.*, 2014). Many commercial human activities introduce sound, either intentionally for a specific purpose, such as seismic surveys, or unintentionally as a by-product of activities such as shipping and offshore and even onshore construction work. Coastal areas and areas where a high degree of human activity takes place, may be quite noisy; including harbours and shipping lanes. However, some high-intensity sources of underwater sound, such as pile drivers and seismic airguns, can be detected over distances of several thousand kilometres. Thus, effects upon fishes may occur well away from the source itself.

There are two main classes of anthropogenic sound. Some sounds are transient or impulsive, while others are continuous. Impulsive sounds are often of short duration (generally well less than 1 s) and may show large changes in amplitude over their time course. They can either be single or repetitive. Examples of such sounds are those produced by seismic airguns, pile driving and underwater explosions. (Various anthropogenic sounds can be heard at: www.go.umd.edu/Ucd.) Most often, such sounds are only present over the course of a particular project and then end.

Continuous sounds are produced by shipping (both commercial and pleasure boats), operational wind turbines, seabed drilling *etc.* and may continue for months or even years (*e.g.*, in a harbour or wind farm). A few of these, described below, are perhaps the most ubiquitous sounds potentially affecting fishes over the widest geographic areas. Sonar systems, while used very widely, generally operate within frequency ranges that are not detectable by fishes (Halvorsen *et al.*, 2012d; Popper *et al.*, 2007).

7.1 | Seismic airguns

Airguns are impulsive sources used for seismic exploration for sub-sea gas and oil reserves as well as for geological research (Gisiner, 2016). These devices use compressed air to produce a gas bubble which expands rapidly when released, creating a high intensity impulsive sound, primarily composed of energy below 200 Hz, but with the bulk of the sound from 20 to 50 Hz (Mattsson *et al*., 2012). The sounds are directed downward into the seabed, though there is also some spreading laterally and they are reflected from various geological formations and then detected by a long array of hydrophones towed by the seismic vessel (see Gisiner, 2016 for a detailed description of seismic surveys).

7.2 | Impact pile driving

Impact pile driving is widely used for the construction of bridges, harbours, wind farms and other offshore structures (Dahl *et al*., 2015; Popper & Hastings, 2009). Striking by the hammer results in vibration of the pile in water and in the substrate, thereby generating sounds that potentially affect nearby animals (Dahl *et al*., 2015; Hazelwood & Macey, 2016). The sounds produced by pile driving are impulsive, short (of the order of μs) and most of their energy lies below 500 Hz, though some energy may extend up to 1 kHz (Dahl *et al*., 2015). The sound levels (both sound pressure and particle motion) vary substantially, depending on numerous factors such as pile diameter, hammer size, substrate characteristics, *etc*. The sounds produced by pile drivers are often very intense with SEL_{ss} often well-exceeding 180 to 200 dB re 1 $\mu Pa^2\ s^{-1}$ and with very sharp rise times.

7.3 | Other industrial activities

Many other industrial activities contribute to underwater noise. Such activities generally produce sound that has the most energy at low frequencies (*i.e*., <1 kHz). Dredging, for example produces high levels of broadband noise (de Jong *et al*., 2016; Wenger *et al*., 2017) and is used to extract sand and gravel from the seabed and from lakes, maintain shipping lanes and to install pipelines and cables within the seabed. Activities onshore, including the passage of vehicles, may increase noise levels in the sea, lakes and rivers, especially if they generate substrate vibration.

7.4 | Operating wind turbines

Since *c*. 2000 there has been an enormous increase in the generation of electricity by wind farms located in coastal waters, especially in European seas. There is some concern that sounds from operating offshore wind turbines might affect fish behaviour, although the sounds generated are very different to those generated during wind-farm construction (Cheesman, 2016). Most sound from a wind turbine is concentrated in a narrow band, centred around 180 Hz and the sounds are generally below about 700 Hz (Madsen *et al*., 2006; Pangerc *et al*., 2016). However, there is also a particle motion component to the sounds generated by wind turbines, accompanying substrate transmission (Sigray & Andersson, 2012; P. Gopu and J. Miller, personal communication, 2018), although this has rarely been monitored and has often been ignored. There is currently limited information available on the acoustic characteristics of offshore turbines, including those utilising tidal and wave energy (Lossent *et al*., 2018; Schramm *et al*., 2017).

7.5 | Vessel noise

A significant proportion of anthropogenic noise in the ocean and other water bodies is created by motorised vessels, including large ships, fishing and pleasure boats (Pine *et al*., 2016; Rossi *et al*., 2016). Most vessels, and especially large ships, produce predominately low frequency sound (*i.e*., <1 kHz) from onboard machinery and hydrodynamic flow around the hull. Cavitation at propeller blade tips is also a significant source of noise across all frequencies (Ross, 1987, 1993). Low frequency sounds from ships can travel hundreds of kilometres and can increase ambient noise levels over large areas of the ocean (Ellison *et al*., 2012; Southall, 2005).

Ambient noise levels in busy shipping lanes have recently increased (Hildebrand, 2009), across much of the frequency spectrum (Sertlek *et al*., 2016), but especially at lower frequencies (<500 Hz; Erbe *et al*., 2012; Bittencourt *et al*., 2014). Large numbers of smaller pleasure and recreational vessels, including things like jet skis (Erbe, 2013), may also result in substantial increases in noise levels in coastal waters, lakes and rivers. Ice-breaking ships can be a significant source of sound in polar regions.

8 | FISH HEARING

8.1 | Hearing capabilities

8.1.1 | Hearing sensitivity

There is a long history of fish hearing studies (Moulton, 1963; Tavolga, 1971). It is likely that all fishes (including elasmobranchs) detect sound and use it to learn about their environment (e.g., Ladich & Fay, 2013). Until recently, however, most studies have focussed on determination of hearing capabilities of fishes to sound pressure signals, despite it being clear that most fishes (and all elasmobranchs) primarily detect particle motion (Popper & Hawkins, 2018). (As an aside, lampreys (Petromyzontidae) also have an ear that has many characteristics in common with other vertebrates and both morphological (Popper & Hoxter, 1987) and recent physiological results (Mickle *et al*., 2018) suggest that they only detect particle motion). There is a need to investigate the hearing abilities of lampreys and many other fishes, under conditions where the particle motion can be monitored or estimated and the ratios of these two potential stimuli can be varied. Such experiments have been reviewed in a number of recent papers, including Hawkins (2014) and Putland *et al*. (2018).

In addition to not focussing on particle motion, many studies have been conducted in tanks, or in poorly designed enclosures in open waters (*e.g*., the experiments by Debusschere *et al*., 2016, which examined effects of pile driving during off-shore wind-farm construction on young European sea bass *Dicentrarchus labrax* (L. 1758) placed in glass 500 ml vials). In such environments, the sound fields presented to the fish are generally very complex and quite unlike the

sound fields that a fish would encounter in a normal aquatic environment (Rogers *et al.*, 2016). As a result, such experiments often leave open questions regarding the actual nature of the sound field to which the animals were exposed and the stimuli to which they responded (Hawkins *et al.*, 2015). Ideally, hearing experiments should be carried out in specially designed tanks (Duncan *et al.*, 2016; Hawkins & MacLennan, 1976; Rogers *et al.*, 2016) or in natural aquatic environments, where both the particle motion and the sound pressure levels can be monitored precisely.

Keeping these caveats in mind, it is possible to get some appreciation of hearing capabilities of fishes. For example, every species studied to date is able to hear. In addition, the majority of fishes detect sounds from <50 Hz, even as low as 10–30 Hz, or even lower (Sand & Karlsen, 2000) to perhaps 300–500 Hz. Fishes that can detect sound pressure hear to perhaps 1000 Hz. And, a much smaller number of species have specialisations that enable them to detect sounds to 3–4000 Hz (Ladich & Fay, 2013).

Because relatively few experiments on the hearing of fishes have been carried out under suitable acoustic conditions, valid data that provide actual hearing thresholds are available for only a few species (thresholds are generally defined as the lowest level of sound that can be detected 50% of the time). Figure 1 shows the measures of hearing, expressed as audiograms. determined in the open-sea, rather than in a laboratory tank, for: the flatfish common dab *Limanda limanda* (L. 1758) (Chapman & Sand, 1974); the Atlantic salmon, *Salmo salar* L. 1758 (Hawkins & Johnstone, 1978); the *G. morhua*; (Chapman & Hawkins, 1973); the Atlantic herring, *Clupea harengus* L. 1758 (Enger, 1967). The *L. limanda* and *S. salar* are only sensitive to particle motion and have a relatively narrow bandwidth of hearing (up to *c.* 300–500 Hz), whereas species like *G. morhua*, where the gas-filled swimbladder is close to the ear, are sensitive to sound pressure and show an increased hearing bandwidth (Fay & Popper, 1974; Sand & Hawkins, 1973).

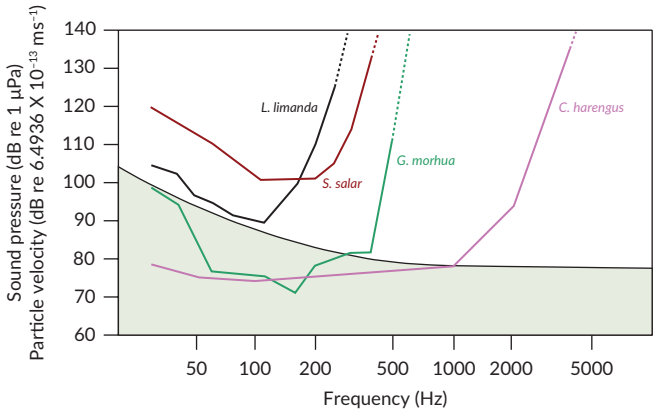

FIGURE 1 Fish hearing sensitivity (thresholds) obtained under open sea, free-field, conditions in response to pure tone stimuli at different frequencies. The lower the thresholds (y-axis), the more sensitive the fish is to a sound. Thus, *Clupea harengus* has best hearing of all of these species over a wider range of frequencies. Note that the thresholds in *Gadus morhua* and *C. harengus* obtained under quiet conditions may be below natural ambient noise levels, especially at their most sensitive frequencies. In the presence of higher levels of noise, the thresholds would be raised, a phenomenon referred to as masking. *Gadus morhua* and *C. harengus* are sensitive to both sound pressure and particle motion, whereas *Limanda limanda* and *Salmo salar* are only sensitive to particle motion. The reference level for the particle velocity is based on the level that exists in a free sound field for the given sound pressure level. *n.b.*, For the particle velocity levels in this figure to match the sound pressure levels in a free sound field it is necessary to calculate an appropriate particle velocity reference level. If the standard reference levels are used, then the curves will not match one another and so they are not included here to keep the figure relatively simple. Fig. © 2018 Anthony D. Hawkins, all rights reserved

It is important to understand that the swimbladder (and other gas-filled cavities) potentially plays a major role in fish hearing. This is because the gas within the swimbladder is compressible and changes volume in response to fluctuating sound pressures (sound) and this results in the swim bladder serving as an acoustic transformer, translating sound pressure into re-radiated particle motion (Sand & Hawkins, 1973). This produces higher levels of particle motion at the ears that stimulates the otolith organs (Popper *et al.*, 2003). Thus, having a gas bubble or a swimbladder close to, or connected to, the ear enhances the hearing abilities of fishes since the ear is not only stimulated directly by the particle motion component of the sound, but also indirectly by the particle motion reradiated from the gas bubble to the ear in response to sound pressure. The actual contribution of the indirect stimulation varies by species and depends on the distance between the bubble and the ear. For example, in *G. morhua*, hearing at low frequencies (<110 Hz), is based on the detection of particle motion, but at higher frequencies it is based on sound pressure due to the closeness of the anterior end of the swimbladder to the ear. Indeed, deflation of the swimbladder in *G. morhua* reduces sensitivity to sound pressure (Sand & Enger, 1973) and similar results have been shown for the goldfish *Carassius auratus* (L. 1758) (Fay & Popper, 1974).

In contrast, species like *S. salar*, despite having a swim bladder, are only sensitive to particle motion since the swimbladder is more distant from the ear (Hawkins & Johnstone, 1978; Knudsen *et al.*, 1992). Other species, such as *C. harengus* (as all Clupeiformes) has a specialised connection between a gas bubble as the ear and shows sensitivity to a much wider range of frequencies and this can extend to >100 kHz in clupeids of the shad family Alosinae (Mann *et al.*, 1998; Mann *et al.*, 2001). Finally, species that do not have a swimbladder or other gas bubble, such as flatfishes, some scombrids and some gobies, only detect particle motion and hear over a narrower bandwidth than *G. morhua*.

In addition to having a gas bubble that improves hearing sensitivity and bandwidth, a number of fish species have additional adaptations that mechanically link the swimbladder to the ear, thereby carrying the motion of the swimbladder to the ear without attenuation of the signal as a result of distance of travel. Best known of these adaptations are the Weberian ossicles, a series of bones that connect the swimbladder to the inner ear in otophysan fishes. (Popper *et al.*, 2003; Popper & Fay, 2011). In other species, the swimbladder has extensions that come close to, or may actually contact, portions of the inner ear and most notably to the saccule, the otolith organ most frequently associated with hearing (Ramcharitar *et al.*, 2006; Schulz-Mirbach *et al.*, 2013).

8.1.2 | Limits to hearing sensitivity: masking

For the more sensitive fishes, hearing is not limited by the lowest level they can hear in a quiet environment, but by their ability to detect and discriminate biologically important sounds against the ambient noise background (Figures 1 and 2). In such conditions, the level of noise limits the lowest sound level that an animal can detect. This interference with detection of a biologically relevant sound by another sound, or noise, is generally known as masking and it is commonly found in all vertebrates, including fishes (Fay & Megela Simmons, 1999). As an example of masking, *G.morhua* only show best hearing sensitivity under the quietest sea conditions (Figure 2; Chapman & Hawkins, 1973). Any increase in the level of ambient sea noise results in a raising of the auditory threshold and a decline in the ability of the fish to detect, locate and recognise particular sounds. Critically, the masking of biologically relevant sounds occurs not only as a result of increases in natural ambient sea noise (caused by wind and rain) but also by any additional sounds added to the environment by humans. However, fishes that do not hear well may be less likely to have their hearing sensitivity affected by masking noise, since the lowest sound level they can detect may be above the level of the background noise (Hawkins & Johnstone, 1978).

Although the detection of sounds may be affected by the presence of masking sounds, it is also clear that fishes can use frequency filters to improve sound detection. They can also discriminate between different sound frequencies and intensities. They are also able to determine the direction from which sounds come (sound source localisation), a critical ability since this enables fishes to move towards potential food sources or away from predators (Fay, 2005; Fay & Megela Simmons, 1999; Hawkins & Popper, 2018; Sand & Bleckmann, 2008).

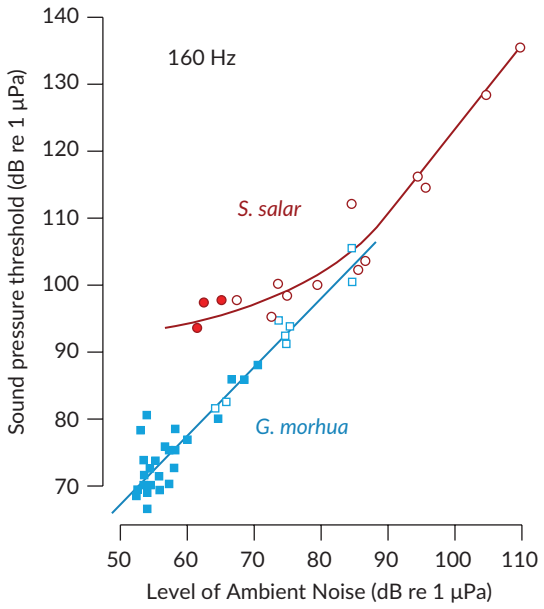

FIGURE 2 Masking in the *Gadus morhua* and *Salmo salar* by ambient noise. The thresholds were determined using a pure tone signal at a frequency of 160 Hz. The ambient noise (natural sea noise, augmented by white noise from a loudspeaker) is expressed as the spectrum level at that same frequency (dB re 1 µPa/Hz). Closed symbols, thresholds to natural levels of ambient noise; open symbols, thresholds to anthropogenic noise. *n.b.*, The thresholds in *S. salar* were only influenced by high noise levels, above the natural ambient levels of noise (data from Hawkins, 1993). Fig. © 2018 Anthony D. Hawkins, all rights reserved

8.2 | The ear

Fishes detect sound with paired inner ears (Figure 3), located in the cranial cavity lateral to the brain at the level of the medulla (Figures 3 and 4), that closely resembles ears found in other vertebrates. Since a fish's body is the same density as water, there is no need for any external structures (external or middle ears) to carry sound to the sensory regions of the ear. The ear consists of three semi-circular canals and associated sensory regions (ampullae) that are primarily involved in detection of angular acceleration and three otolith organs (saccule, lagena, utricle) that are involved in hearing and positional senses (Popper *et al.*, 2003). There is very substantial variation in the morphology of the ears of fishes and particularly in the regions associated with hearing (Ladich & Schulz-Mirbach, 2016; Retzius, 1881; Schulz-Mirbach *et al.*, 2018; Schulz-Mirbach & Ladich, 2016), leading to the suggestion that there is very substantial diversity in hearing mechanisms (and potentially capabilities) in different species (Popper *et al.*, 2003).

The auditory parts of the ear, the otolith organs, each have a sensory epithelium that lies in close contact with a dense calcium carbonate structure, the otolith (Figures 3 and 4). The sensory epithelium (often referred to as a macula) has many sensory hair cells that are very similar to those found in the mammalian ear (Figure 5). When a fish is exposed to particle motion, the body, along with the sensory cells, move with the water, while the far denser otoliths move at a different amplitude and phase. This results in bending of the cilia on the apical surface of the sensory cells, releasing a neurotransmitter and sending a signal to the brain through an afferent neuron.

A critical role of the ear in fishes is involvement with determination of sound source direction (Hawkins & Popper, 2018). The sensory hair cells are morphologically polarised and the response of an individual cell changes with bending in different directions. Thus, each cell is directionally sensitive. Furthermore, the cells are organised into orientation groups in which all of the kinocilia are in the same direction (Figure 5). These hair cell orientation patterns, which vary in different species (Popper & Coombs, 1982), show graded responses to particle motion from various directions, thereby enabling a fish to determine direction by comparing information from different receptor groups (Fay, 2005; Hawkins & Popper, 2018; Sand & Bleckmann, 2008).

9 | EFFECTS OF ANTHROPOGENIC SOUND

There are very few experimental examples of sound being sufficiently loud to result in death or mortal injury to fishes. However, far more importantly from the perspective of potential effects, is that anthropogenic sound, even at levels far lower than those that might result in mortality, may result in temporary hearing impairment, physiological changes, changes in behaviour and the masking of biologically important sounds (Table 1; Popper *et al.*, 2014;

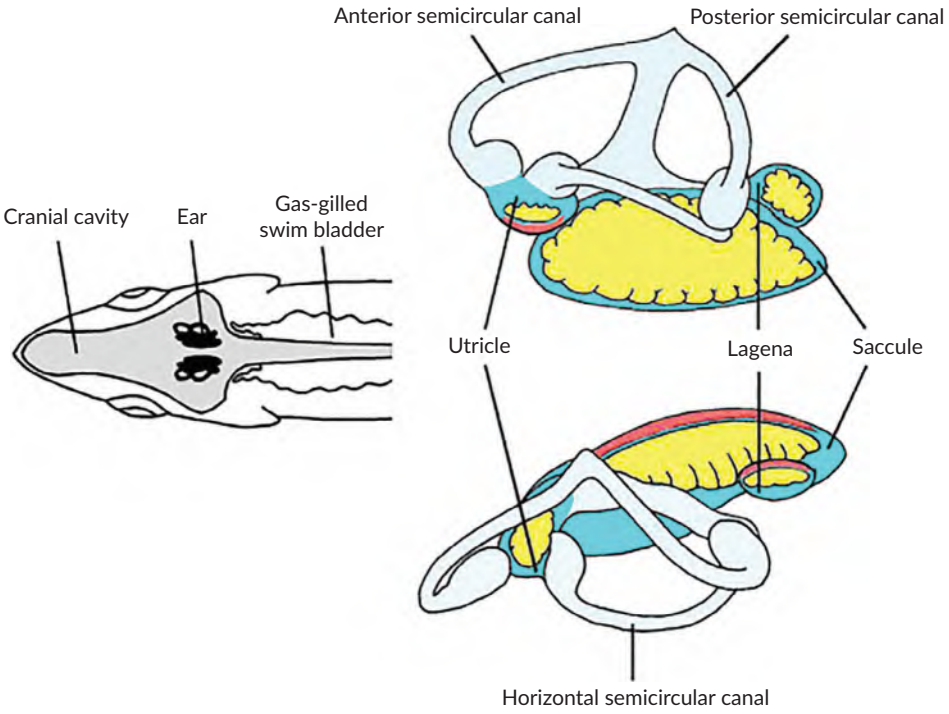

FIGURE 3 Schematic drawing of the ear of *Gadus morhua* (anterior is to the left): (a) top view of the body showing the location of the ears in the cranial cavity as well as the proximity of the rostral end of the swim bladder to the ear; (b) lateral and (c) top view of the same ear. Each ear is set at an angle relative to the midline of the fish. ■, The otolith organs, ■, the semicircular canals (enlarged areas are the ampullae regions that contain the sensory cells); ■, the dense calcarious otolith lying in close proximity to the sensory epithelium (■). Also see Figure 4. Fig. © 2018 Anthony D. Hawkins, all rights reserved

Erbe *et al*., 2016). There may be significant consequences to individuals and populations as a result of changes in behaviour, including impairment of spawning, interference with foraging and feeding, or disruption of migrations and habitat selection. Exposure to sound may also (but not always) result in physiological changes that may include stress effects (Filiciotto *et al*., 2016). However, as pointed out by Hawkins *et al*. (2015), there are large gaps in our knowledge of effects of sound on fishes that need to be filled if we are to fully understand the implications of exposure to anthropogenic sounds.

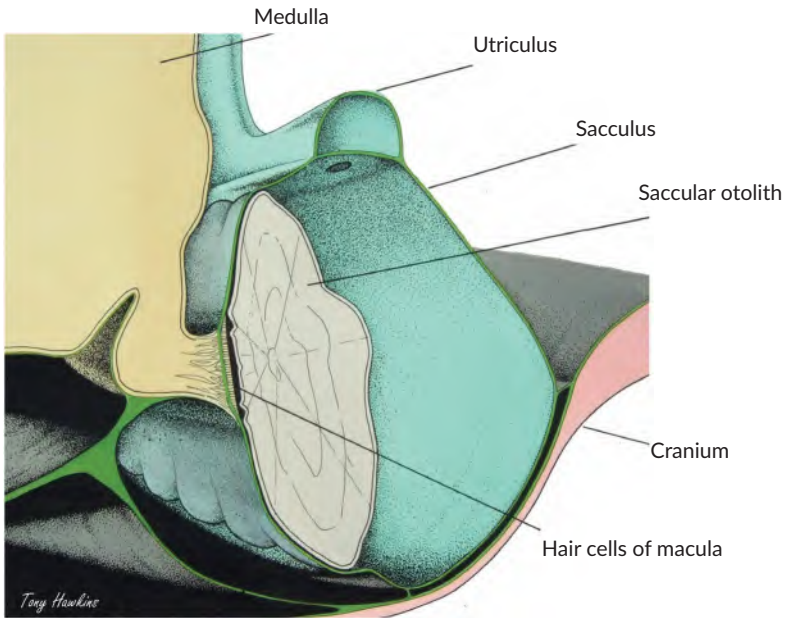

FIGURE 4 A frontal view of the head of *Gadus morhua* showing a section of the saccule (■). The saccular chamber is filled with perilymph and contains the otolith (■), which lies close to the sensory hair cells of the epithelium (macula). The hair cells are innervated by the eighth cranial nerve. Fig. © 2018 Anthony D. Hawkins, all rights reserved

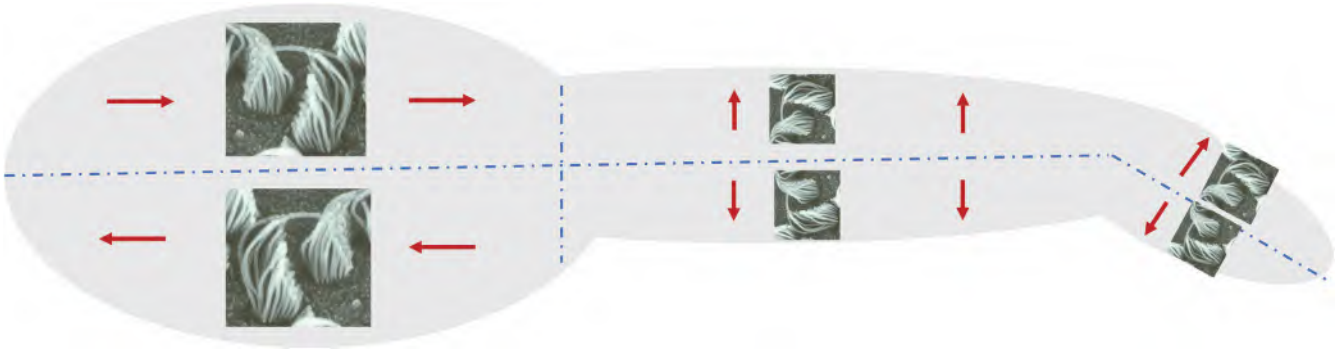

FIGURE 5 The sensory epithelia of the end organs of the inner ear have numerous mechanoreceptive sensory hair cells. The apical ends of these cells, directed into the lumen of the epithelia, have ciliary bundles (inserts in the figure) consisting of a single kinocilium (longest of the cilia) and graded stereocilia. Bending of the ciliary bundle during sound stimulation results in neurotransmitter release to stimulate the 8th cranial nerve. The sensory cells on the otolith maculae are organized into orientation groups, with all of the cells in each group having their kinocilia in the same general direction. In this typical saccular epithelium (anterior to the left, dorsal to the top), the cilia on the rostral end are oriented rostrally or caudally, while the cells on the caudal end are oriented dorsally and ventrally. – – –, The approximate dividing lines between orientation groups)

TABLE 1 Potential effects of anthropogenic sound on animals

Effect	Description
Death	Sound exposure results in instantaneous or delayed mortality.
Physical injury & physiological changes	Physical injury results in temporary or permanent impairment of the structure and functioning of some parts of the body. Physiological changes result in increased stress or other effects that can lead to reduced fitness.
Hearing threshold shift	Loss of hearing, temporarily or permanently, results in decreased ability to respond to biologically relevant sounds.
Masking	Noise results in a decrease in detectability of biologically relevant sounds (*e.g.*, sounds of predators and prey, sounds of conspecifics, acoustic cues used for orientation).
Behavioural responses	Behavioural responses include any change in behaviour from small and short-duration movements to changes in migration routes and leaving a feeding or breeding site. Such responses are likely to vary from species to species, depending on numerous factors such as the animals normal behavioural repertoire, motivational state, time of day or year, age of the animal, *etc.* Some changes in behaviour, such as startle reactions, may only be transient and have little consequence for the animal or population.
No obvious behavioural responses	Animals may show transient or no responses, even if they detect the sound (*e.g.*, to a very low-level sound) or habituation may take place. However, even if there is no response, there is always the possibility that physical injury and physiological changes may take place without the animal showing overt changes in behaviour

9.1 | Effects upon behaviour

9.1.1 | Caveats in interpretation of laboratory studies

In evaluating data on potential behavioural effects of anthropogenic sound on fishes it is important to first appreciate a number of caveats that are critical to interpretation of various studies. In particular, one must be cautious when evaluating the results from behavioural studies done in tanks and even in larger enclosures (Hawkins & Popper, 2016b; Popper & Hawkins, 2018). The fundamental issue is that captive animals, no matter whether on land or in the water, often do not show the full range of behaviours observed in wild animals (Benhaïm *et al.*, 2012; Oldfield, 2011), especially if they have been bred in captivity (El Balaa & Blouin-Demers, 2011; Petersson *et al.*, 2015). As a result, data from studies using free-living fishes are very likely to differ from those with captive fishes because of the many subtle factors that determine their behaviour in a natural setting. Put another way, one must take very considerable caution in extrapolating behaviour from studies of captive animals to how wild animals may respond to the same stimulus.

A second critical caveat is that when studies are done in tanks and other enclosures the sound fields may be very different from those that fishes experience in the wild, especially in terms of the magnitude of particle motion relative to sound pressure (Duncan *et al.*, 2016; Gray *et al.*, 2016; Rogers *et al.*, 2016). Many fishes live close the substrate, or occupy burrows, coral reefs, mangroves and kelp forests, where sound transmission may be especially complex; while others may occupy open waters. None of these acoustic environments, however, are anything like that in a fish tank where walls are thin and often made of glass or flexible material. Consequently, the walls of tanks vibrate and set up highly perturbed sound fields that would have ratios of pressure and particle motion unlike those that an animal would ever encounter in the wild (Parvulescu, 1964; Rogers *et al.*, 2016). Thus, even if a fish shows a particular behaviour pattern in response to a tank-based sound, the same sound produced in the wild may have very different acoustic characteristics and thus may or may not elicit the same behaviour as in the tank. It is important to monitor the particle motion as well as the sound pressure and where possible to ensure that the acoustic conditions under which experiments are conducted are similar to those the fish would experience in the wild. Where the particle motion is properly monitored as well as the sound pressure, some physiological experiments on captive animals may provide some useful information on the levels that produce particular effects. However, it is necessary to be circumspect in extrapolating the findings to wild animals.

Finally, in considering behaviour, it is also important to recognise that the responses of fishes may vary with their age and condition, as well as under different environmental conditions. Moreover, responses may vary with different sound sources, or with the same

sound when the level of sound received by the animal differs (De Robertis & Handegard, 2013; Lucke *et al*., 2016).

9.1.2 | Behavioural responses to sound

Sounds can have several different types of behavioural effects. Some fishes may react negatively to a sound. There may be changes in feeding or mating; migratory paths may be altered; and the finding of places for larval settlement may be disrupted. Anthropogenic sounds may interfere with detection of the overall acoustic scene (or soundscape) as well as affecting sound communication by fishes. Masking may result in lessened ability to detect biologically significant sounds and may also result in the generation of signals that are similar to those produced by the fish themselves (Kaplan *et al*., 2015; Kaplan *et al*., 2016; Pine *et al*., 2016).

There has been a variety of studies of the potential effects of anthropogenic sound on fish behaviour. However, many of those studies must be considered with great caution since they were done in laboratory tanks, or on species, such as the zebrafish *Danio rerio* (Hamilton 1822), that appear to thrive in captivity, unlike many other species, and which are behaviourally and physiologically very different to the important commercial species such as salmonids, gadids, sciaenids, *etc*. Extrapolation from laboratory fishes to commercially important species must be done with the greatest caution.

At the same time, some observations from recent behavioural studies do provide instructive insight and guidance. For example, while it is generally assumed that fishes with better hearing abilities, are more likely to show behavioural responses to sounds than less sensitive species, this may not always be the case. Comparisons of laboratory responses of *D. rerio* and Lake Victoria cichlids, such as *Haplochromis piceatus* Greenwood & Gee 1969, to sounds, the former having better hearing sensitivity (lower auditory thresholds) and a wider frequency range than the latter, showed that both species exhibited a significant reduction in swimming speed in the first minute of exposure that were not obviously related to differences in their hearing abilities (Shafiei Sabet *et al*., 2016). Similarly, Hawkins *et al*. (2014) showed that changes in the behaviour of schools of wild sprat *Sprattus sprattus* (L. 1758) and mackerel *Scomber scombrus* L. 1758, to sound playback took place at similar sound levels, despite major differences in their hearing abilities.

9.1.3 | Responses to continuous sounds

Many anthropogenic sources produce long-duration signals that can increase the overall sound level in the environment for extended periods of time. Increased shipping in a harbour, increased pleasure boats on a reef, or continuous operation of an offshore wind turbine or oil rig, may change the acoustic environment to which a fish is adapted. Consequently, critical aspects of fish behaviour could be interfered with by the presence of long-term sounds that mask a fish's ability to detect sounds of biological importance to the animals. A wide range of behaviour patterns may be affected by increased background noise. For example, anthropogenic sounds may interfere with foraging behaviour either by masking the relevant sounds or by resembling the sounds that the prey may generate (Purser & Radford, 2011). Similarly, fishes may avoid predators by listening for the sounds that the predators produce, either deliberately or inadvertently. Studies have shown that elevated sound levels, including intermittent or pulsed sounds, may affect predator prey interactions (Luczkovich & Keusenkothen, 2008; Remage-Healey & Bass, 2006). It is evident that anthropogenic noise can affect predator avoidance in some fishes. At the same time, however, it must be kept in mind that all studies on predator avoidance to date have involved captive fish in enclosed environments. Clearly, there is a need to examine the behaviour of wild fishes under more natural conditions.

Another issue is that many fishes migrate to feeding areas or spawning grounds and may subsequently return to other locations. During migrations, fishes may use a variety of cues to orientate and navigate, including natural soundscapes. High level sounds may result in avoidance responses, deflecting fish away from their migration routes. For example, Montgomery *et al*. (2006) suggested that the ability of larval reef fishes to locate their home reefs by responding to their characteristic sounds might be affected by changes in the noise level (Stanley *et al*., 2012). There are significant differences in the spectral and temporal composition of the ambient sound associated with different coastal habitat types (Radford *et al*., 2010) and Gordon *et al*. (2018) recently pointed out that changes in habitats may negatively affect the auditory settlement behaviour of coral-reef fishes. Acoustic cues guide the orientation, habitat selection and settlement of many fishes, but these processes may be impaired if degradation alters reef soundscapes.

Sounds are also important for many fish species for spawning. In particular, any interference with detection of spawning sounds can have a significant effect on reproductive success of a population. For example, Casaretto *et al*. (2015) showed that male *M. aeglefinus* are territorial and that visits to their territories by females, induced by the sounds of males, triggered courtship behaviour, leading to the spawning embrace It has been suggested by de Jong *et al*. (2017) that acoustic communication may play a crucial role in reproductive interactions and they point out that over 800 species of fish have been found to communicate acoustically.

In addition to affecting the detection of biologically important sounds, there is also limited evidence that anthropogenic sounds will result in fishes altering their own sounds to avoid masking (Radford *et al*. (2014). Similarly, Holt and Johnstone (Holt & Johnston, 2014; Holt & Johnston, 2015) investigated effects of elevated noise levels on a sound-producing freshwater fish, the black-tail shiner *Cyprinella venusta* Girard 1856, in tanks. When elevated levels of natural river noise were played back to the fish, it was found that several acoustic features of the fish calls were altered under noisy conditions. Most notable the spectral composition of the calls was altered by the fish (termed the Lombard effect).

9.1.4 | Observed effects from impulsive sound sources

Especially important are the sounds produced by impulsive sources. Such sounds are typically transient, brief (< 1 s), broadband and show high peak sound pressure with a rapid rise time and rapid decay. The greater amount of (still very limited) data available on behavioural responses to impulsive sound comes from studies of pile driving sounds. Moreover, most of these behavioural studies have been

conducted on captive fish, maintained in confined spaces (Herbert-Read *et al*., 2017; Spiga *et al*., 2017), though a few recent studies have been conducted on fishes in the wild (Hawkins *et al*., 2014; Iafrate *et al*., 2016; Roberts *et al*., 2016a). For example, Hawkins *et al*. (2014) observed the behaviour of schools of *S. sprattus* and *S. scombrus* in mid water at a quiet coastal location, using an echosounder. *Sprattus sprattus* is sensitive to sound pressure, while the *S. scombrus* is likely to be sensitive only to particle motion. The fish were exposed to short sequences of repeated impulsive sounds, simulating the strikes from a pile driver, at different sound levels. Results showed that the incidence of behavioural responses increased with increasing sound level. The response levels suggested that both species would show changes in their behaviour at considerable distances (many kilometres) from a pile driving operation. However, the responses of *S. sprattus* at night were very different to those shown during the day. *Sprattus sprattus* schools break up at night and the individual fish did not respond to the playback of pile driving sounds at that time.Despite major differences in their hearing abilities the *S. sprattus* and *S. scombrus* responded in the daytime playback experiments to impulsive sounds at similar sound levels. This may be the result of *S. scombrus* being readier to respond to any stimulus, observations suggested that they were perhaps flightier than *S. sprattus*. However, this, like most other aspects of how fishes respond behaviorally to anthropogenic sound, still needs extensive study.

There have also been a number of studies of the response of captive demersal species to pile driving sounds. For example, Neo *et al*. (2014) found that that intermittent sounds may yield longer-lasting behavioural effects than continuous sounds (Neo *et al*. 2015). Moreover, ramp-up procedures, where sounds are slowly increased in level so as to warn fishes of impending sounds, do not necessarily lead to mitigation (Neo *et al*. 2016). At the same time, these studies were done in enclosures that did not resemble natural acoustic environments and many were done with *D. rerio*, a species that is small, thrives in small tanks and which hears far better than most (if not all) species likely to be exposed to pile driving operations.

Kastelein *et al*. (2015, 2017) determined acoustic dose–response relationships for behavioural responses to the play back of pile driving sounds by *D. labrax* in a netting enclosure within a very shallow rectangular pool, where the sound field was nothing like that in the wild. It was concluded that if wild *D. labrax* were exposed to pile driving sounds at the levels used in the study, there were unlikely to be any adverse effects on their ecology, because their initial responses were short-lived. However, the experiments were carried out on fish that had spent their whole lives in captivity.

In a more detailed series of experiments on laboratory-bred juvenile *D. labrax*, Radford *et al*. (2016) exposed fish to playbacks of pile driving sounds and seismic sounds in laboratory-based studies intended to examine how an initial response to different sound types potentially changes over time. The study found a lessened response after repeated exposure to pile driving sound and it was concluded that this was probably due to increased tolerance (habituation), or a shift in hearing threshold (temporary threshold shift; TTS or permanent threshold shift; PTS) following initial exposure.

Roberts *et al*. (2016a, 2016b) examined the responses of a number of wild demersal species to the playback of pile driving sounds and elicited behavioural responses including startle responses and directional avoidance. The exposure levels were similar to the 50% response levels determined by Hawkins *et al*. (2014) for schools of *S. sprattus* and *S. scombrus* using the same sound projector array. However, Roberts *et al*. (2016b) emphasised that while the waterborne component of the sound was accurately reproduced by the sound projectors, the projectors were not able to replicate the additional substrate-borne vibrations that pile drivers produce.

The conclusion from all of these studies is that we really know very little as to how fish behave in the wild to impulsive signals. This is because most studies were done in the laboratory where the sound stimulus is of great question and where fishes cannot show natural behaviour. Moreover, there was considerable variation in species, age of fish and whether the animals were raised in captivity or not. Nevertheless, there have been studies that examined the behavioural responses of large groups of fishes to the impulsive sound of seismic surveys in the wild. However, these studies, unlike the ones cited earlier, were not designed to examine the behaviour of individual or small groups of fishes. Instead, these studies examined changes in the distribution of wild fishes in the presence of an actual seismic survey. The horizontal and vertical distributions of both pelagic and demersal fishes have been shown to change during and after airgun operations (Løkkeborg *et al*., 2012), although they generally returned to the original site within hours or days after the end of the seismic operation (Engås *et al*., 1996; Engås & Løkkeborg, 2002). Other studies have shown that fish may respond to approaching vessels by diving towards the seafloor or by moving horizontally out of the vessel's path, with reactions often initiated well before the vessel reaches the fish (Ona *et al*., 2007).

9.2 | Effects upon hearing sensitivity

Exposure to sounds may result in hearing loss as a result of damage to the sensory cells of the inner ear or the innervating neurons. While temporary hearing loss (TTS) occurs in fishes, there is no evidence for permanent hearing loss (PTS). Indeed, PTS may not occur in fishes since they can repair or replace sensory hair cells of the inner ear that have been lost or damaged (Smith *et al*., 2006; Smith & Monroe, 2016). TTS is a short duration decrease in hearing sensitivity resulting from exposure to intense sounds or sounds of long duration. After termination of the sound, normal hearing ability returns over a period that may range from minutes to days, depending on many factors, including the intensity and duration of exposure (Amoser *et al*., 2004; Smith *et al*., 2006; Smith & Monroe, 2016). However, during a period of TTS, animals may be placed at some risk to survival in terms of poorer communication, inability to detect predators or prey and difficulty in assessing their environment.

TTS has been demonstrated in a number of fish species from a diverse array of sounds (Smith & Monroe, 2016) but in all cases, TTS was only found after multiple exposures to intense sounds (*e.g*., < 190 dB re 1 μPa rms) or as a result of long-term exposure (*e.g*., tens of minutes or hours) to somewhat less intense sounds. Even when a signal source caused TTS in some individuals or species, it did not occur in other specimens or other species (Popper *et al*., 2005; Popper *et al*., 2007). In most cases, normal thresholds returned within a few

hours to several days. There is also evidence that, given the same type and duration of sound exposure, a much more intense sound will be required to produce TTS in fishes that do not hear well compared with fishes that do hear well (Popper *et al.*, 2007; Smith *et al.*, 2004). Since TTS can arise from prolonged exposure to sound (though this is not always so), it is not likely to be of great significance for fishes that are only briefly exposed to a source (Halvorsen *et al.*, 2013; Popper *et al.*, 2007).

Of far greater concern is that TTS may occur when there is long-term noise exposure such as in harbours and other areas where there is a long-term increase in sound level. While limited, TTS is correlated with damage to sensory hair cells of the ear and it has been shown that recovery from TTS occurs in parallel with repair or replacement of sensory cells (Smith *et al.*, 2006; Smith *et al.*, 2011). Other studies have shown that exposure to intense sound may result in hair cell damage, but they did not examine whether this was accompanied by a loss of hearing (Casper *et al.*, 2013b; Enger, 1981; Hastings *et al.*, 1996; McCauley *et al.*, 2003). At the same time, studies of other species or other types of intense sounds have not resulted either in TTS or hair cell damage (*e.g.*, Halvorsen *et al.*, 2013; Popper *et al.*, 2005; Popper *et al.*, 2007).

Clearly, there is still a question as to whether TTS occurs in fishes exposed to anthropogenic sounds and, if so, which sounds will result in TTS. Moreover, there appears to be broad species variation as to whether TTS will occur and there is even evidence that different genetic stocks of the same species may or may not show TTS (Halvorsen *et al.*, 2013; Popper *et al.*, 2007). Moreover, none of the studies on TTS to date have determined whether the loss of hearing (or lack of loss of hearing) is correlated with exposure to sound pressure or particle motion. Finally, none of the studies have been done on wild animals where there is the potential to escape from areas of intense sounds, or to test whether a small change in hearing threshold has any real impact on fitness (Popper *et al.*, 2014).

9.3 | Stress

Animals showing no overt sign of responding to an environmental stimulus may, nonetheless, experience physiological changes that are often referred to as stress responses. These are often similar to stress effects to sound exposure found in terrestrial animals (Gourévitch *et al.*, 2014; Kight & Swaddle, 2011; Weilgart, 2017; Wysocki *et al.*, 2006). Stress may include hormonal, autonomic, immune and behavioural responses that may initially allow fishes (as other animals) to adapt to adverse conditions. However, some stressors may change the state of physiological processes and affect homeostasis, thus having an adverse effect upon the animals' health and well-being. Very little is known about stress effects in fishes and the significance of such effects in response to anthropogenic sounds is even less clear (Tennessen *et al.*, 2016).

There is an increasing body of literature on potential stress effects of exposure to both continuous and impulse anthropogenic sounds (Buscaino *et al.*, 2010; Celi *et al.*, 2016; Nedelec *et al.*, 2015; Sierra-Flores *et al.*, 2015). However, as for behavioural studies, there is a wide range of species used, a diverse set of exposure paradigms, very different results depending on species and paradigm, and, most importantly, all of these studies have been done in the laboratory. Consequently, one must be cautious in extrapolating to how a fish might respond to a stressor in the wild where the fish's movement is not restrained and it could, potentially, move away from a stressor. It is also important to distinguish between normal or tolerable variations in response to environmental stress from those changes that will have consequences for survival and reproduction. At present, critical examination of these long-term changes in fishes as a result of sound exposure is lacking.

In considering potential physiological effects, a critical issue is that potential effects of sounds on the physiology of fishes, as measured by various stress parameters, are quite variable and are not particularly instructive with regard to how exposure might affect fishes. In particular, all of the studies to date, including both long and short-term exposures, were made on captive animals in enclosed areas where the fishes could not avoid the sounds. Thus, the acoustics were different than those an animal would encounter in the wild and the fish could not move away from the disturbing sound. Thus, it is possible that it is not the sound itself that resulted in the stress response, but the inability of the animals to move away from the sound.

9.4 | Death and injury

Death and injury of fishes are probably the most easily observed responses to high levels of anthropogenic sound. However, there are only the most limited data on mortality in fish from sound exposure and these are when animals are very close to pile driving sources (California Department of Transportation, 2001), but not for other sound sources. Indeed, exposure of fishes to very high intensity low and mid-frequency sonars resulted in no mortality (Halvorsen *et al.*, 2013; Popper *et al.*, 2007), nor did exposure to seismic airguns (Popper *et al.*, 2005; Popper *et al.*, 2016). There are, however, some data showing that fishes receiving high intensity and particularly impulsive, sounds will experience damage to body tissues. This damage appears to result from rapid oscillation of the walls of the swimbladder when stimulated by an impulsive source. In such cases, it appears that the swimbladder expands and contracts rapidly, thereby damaging the proximate organs including liver, kidney, gonads and the swimbladder itself (Halvorsen *et al.*, 2012b; Halvorsen *et al.*, 2012c). For example, of five species exposed to high intensity simulated pile driving signals (Casper *et al.*, 2013a; Halvorsen *et al.*, 2012b; Halvorsen *et al.*, 2012c), only the hogchoker *Trinectes maculatus* (Bloch & Schneider 1801), a flatfish without a swim bladder, showed no tissue damage (Halvorsen *et al.*, 2012b). At the same time, exposure to very high intensity continuous signals that did not contain any impulsive components showed no tissue damage in five different species (Halvorsen *et al.*, 2012d; Halvorsen *et al.*, 2013; Kane *et al.*, 2010; Popper *et al.*, 2007).

A recent set of studies, using a pile driving sound as a stimulus, enabled investigators to quantify the physical effects of sound exposure on various tissues (Casper *et al.*, 2012; Casper *et al.*, 2013a, 2013b; Casper *et al.*, 2017; Halvorsen *et al.*, 2012a, 2012b, 2012c; Popper *et al.*, 2013). While these results directly relate to pile driving, they are also likely to give guidance for potential effects of other impulsive sounds on fishes and so they have been incorporated into

the most recent guidelines for fishes on interim sound exposure criteria (Table 2; Popper *et al*., 2014; Andersson *et al*., 2017).

In brief, results from these studies showed a general correlation between the extent of tissue damage and the cumulative level of sound energy to which fish were exposed. For example, there was no tissue damage in one of the main study species, Chinook salmon *Oncorhynchus tshawytscha* (Walbaum 1792), following exposure to sounds below an SEL_{cum} of 210 dB re 1 μPa^2 s^{-1}. At an SEL_{cum} that was a few dB higher (but with sounds given over the same time period), internal injuries started to appear and when the level reached 219 dB re 1 μPa^2 s^{-1} there were massive internal injuries that would likely result in death. Studies with other species showed that while there is some variation in SEL_{cum} required for onset of physiological effects, this is always at SEL_{cum} levels >203 dB re 1 μPa^2 s^{-1} (Casper *et al*., 2013a; Halvorsen *et al*., 2012b).

At the same time, results show that the effects do not support the idea of an equal energy hypothesis, which is an idea based on the premise that the same effect will show up as long as the total energy to which a fish is exposed remains the same (Woodbury & Stadler, 2008). Instead, experimental results clearly show that the degree of effect depends upon a combination of the energy within single strikes (SEL_{ss}) and the number of strikes, but the effect is not predictable from just knowing the cumulative energy (Casper *et al*., 2016; Halvorsen *et al*., 2012c).

Studies subsequently found that *O. tshawytscha* and hybrid white bass *Morone chrysops* (Rafinesque 1820) x striped bass *Morone saxatilis* (Walbaum 1792), recovered from all apparent physical effects within 10 days of exposure (Casper *et al*., 2012, 2013a). However, it was made clear that recovery took place in the laboratory and that animals in the wild with similar injuries would have lower fitness and be more susceptible to predation and disease until they fully recovered. This is a concrete example of the need to be cautious in interpreting the results of laboratory experiments.

An additional question was whether hearing was affected by exposure to up to 960 sequential simulated pile strikes. Limited data showed that damage to ear tissues did not show up until the SEL_{cum} was 216 dB re 1 μPa^2 s^{-1} (Casper *et al*., 2013b). However, both species studied have swim bladders that terminate some distance from the ear and so movement of the swimbladder walls would not directly affect the inner ear. It is possible that fishes with gas-filled organs near or directly associated with the ear would show damage at lower sound exposure levels due to the impulsive movement of the organ walls, much as they damage other nearby tissues.

10 | EFFECTS ON FISH POPULATIONS AND THE WIDER ECOSYSTEM

The studies described previously have largely dealt with effects upon individual animals. However, for fishes, unlike marine mammals, perhaps the greater concern lies with effects upon populations rather than individuals (Hawkins & Popper, 2016a; Pirotta *et al*., 2018). The extent to which sound affects the structure and functioning of fish populations and ecosystems, both marine and freshwater, is probably of considerable importance, although such effects have yet to be established.

Attempts to model changes in population parameters were first addressed for marine mammals. The population consequences of acoustic disturbance (PCAD) approach (NRC, 2005), recognises that there may be significant effects at individual, population and ecosystem levels. The population consequences of disturbance (PCoD) approach (Harwood *et al*., 2014) is a formal, mathematical version of the PCAD model that uses the opinions of experts to quantify the transfer functions that describe the relationships between the different compartments of the PCAD model. It provides a protocol that can be used by regulators and developers to examine how sound exposure might impair the ability of individual animals to survive, breed,

TABLE 2 Proposed interim criteria for mortality and recoverable injury from exposure to pile driving signals are based on 960 sound events at 1.2 s intervals (Halvorsen et al., 2012b, 2012c). Temporary threshold shift (TTS) based on Popper et al. (2005). The same peak levels are used both for mortality and recoverable injury since the same sound exposure level (SEL_{ss}) was used throughout the pile driving studies. All criteria are presented as sound pressure even for fishes without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms: N, near; I, intermediate; F, far (from Popper et al., 2014)

		Impairment			
Type of Animal	**Mortality and potential mortal injury**	**Recoverable injury**	**TTS**	**Masking**	**Behaviour**
Fish: no swim bladder (particle motion detection)	> 219 dB SEL_{cum} or > 213 dB peak	> 216 dB SEL_{cum} or > 213 dB peak	>>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{cum} or > 207 dB peak	203 dB SEL_{cum} or > 207 dB peak	> 186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{cum} or > 207 dB peak	203 dB SEL_{cum} or > 207 dB peak	186 dB SEL_{cum}	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	210 dB SEL_{cum} or > 207 dB peak	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and larvae	> 210 dB SEL_{cum} or >207 dB peak	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 μPa^2 s^{-1}.

reproduce, or rear young and to quantify how this impairment may affect the abundance of the species concerned.

For species where there is limited knowledge of ecological interactions, an alternative risk assessment tool is required. Fisheries biologists have recently considered new risk-based approaches in assessing the effects of fishing upon species for which there are only limited data on key population parameters. The productivity susceptibility assessment (PSA) approach (Patrick *et al.*, 2010) has been applied to fish stocks to determine the effect of human activities upon fishes. Such an approach attempts to evaluate the vulnerability of fish stocks to fishing; based on their biological productivity and potential for resisting adverse effects. This approach has been increasingly used to identify species at risk within multispecies fisheries (Hobday *et al.*, 2011; Smith *et al.*, 2007) and may have wider applicability in assessing risks from noise exposure.

11 | SOUND EXPOSURE CRITERIA AND GUIDELINES

Sound exposure criteria essentially define those levels of sound from different sources that are likely to affect aquatic animals adversely, in order to regulate the generation of noise in aquatic environments. Significant efforts have been made over the past few years to develop criteria for aquatic vertebrates, including marine mammals, as well as guidelines for the use of these criteria (NMFS, 2018; Southall *et al.*, 2007).

Substantially less effort has been placed on developing criteria and guidelines for fishes. However, interim sound exposure criteria for the onset of physiological effects on fishes for use on the United States west coast were proposed by the Fisheries Hydroacoustics Working Group (FHWG, 2008) but also see Popper *et al.* (2006) and Woodbury and Stadler (2008). More recently, a new set of interim criteria was proposed (Popper *et al.*, 2014) based on a much stronger set of research and these raised the effective onset of effects levels, at least for physical effects, substantially and these interim criteria are now being used world-wide (Andersson *et al.*, 2017).

Most work to date has focussed upon effects on marine mammals and marine fishes; much less is known about these effects in fresh water. However, Mickle and Higgs (2018) have recently reviewed the literature regarding behavioural and physiological effects of noise pollution on freshwater fish and have emphasised the lack of incorporation of both behavioural and physiological measures within current studies. Marine and freshwater soundscapes differ quite markedly and the transmission of sound through shallow lakes and rivers differs substantially from that under open-water conditions in the sea. Substrate transmission of sound may be especially important in shallow freshwater environments. Thus, there is a need to examine those types and levels of sounds that are harmful to freshwater fishes and to establish relevant sound exposure criteria.

11.1 | Current interim guidelines

The term onset and the phrase onset of effect have been widely used in preparing guidelines on sound exposure criteria. However, it is clear that onset is viewed very differently by different investigators, regulators and others and that there is no clear definition of the term, particularly with regard to the potential effects of sound on fishes. In this review, onset refers to the lowest sound level that results in a statistically significant effect, in terms of physical damage to an animal or a significant change in behaviour. It should be noted that earlier papers that considered fishes used onset for any level of response, including a response by a single animal in a school (Woodbury & Stadler, 2008). Thus, if there is scale loss in one fish within a group of many animals, that would be considered onset.

11.1.1 | Onset of physical effects

The interim sound exposure criteria, which are still in use, at least on the U.S. west coast (Caltrans, 2015; www.go.umd.edu/UcP), were based on a recommendation of dual criteria of peak sound pressure (SPL_{peak}) and cumulative SEL (SEL_{cum}) (Carlson *et al.*, 2007; Popper *et al.*, 2006; Popper & Hastings, 2009).

The rationale for dual criteria was that it was sometimes hard to determine one or the other measure when trying to set a signal level for onset of an effect and having alternative approaches provides a more conservative guideline for the protection of the animals. The SEL_{cum} was suggested since animals are often exposed to many more than a single pile driving strike in succession and any effect would probably come from an accumulation of energy from the multiple strikes. However, as noted above, it is now clear that the SEL_{cum} is probably an inappropriate measure of potential effects.

In 2008, the Fisheries Hydroacoustic Working Group adopted the interim dual-criteria model for onset of physiological effects from sound exposure (FHWG, 2008). However, these criteria were immediately criticised since they were based on very limited scientific research on effects of pile driving on fishes (Carlson *et al.*, 2007; Popper & Hastings, 2009). The criteria were: Peak (SPL): 206 decibels (dB) re 1 μPa; SEL_{cum}: 187 dB re 1 $\mu Pa^2\ s^{-1}$ for fishes above 2 g; SEL_{cum}: 183 dB re 1 $\mu Pa^2\ s^{-1}$ for fishes below 2 g.

11.1.2 | Onset of behavioural effects

The U.S. National Marine Fisheries Service (NMFS), as well as other agencies, currently uses 150 dB re 1 μPa (rms) as the sound pressure level that may result in onset of behavioural effects (Caltrans, 2015). This is based on a recent NMFS guidance document (www.go.umd.edu/Ucs) that says that sound pressure above the 150 dB_{rms} level are expected to cause temporary changes in behaviour and these might include startle responses (though startle is not defined and has broad meaning to fish biologists), feeding disruption, area avoidance, *etc.* However, there are a number of problems with the 150 dB_{rms} criterion. First, its origin and scientific basis is not known (Hastings, 2008). Second, the value is based on the assumption that fishes respond to sound pressure even though, as pointed out earlier, most fishes primarily detect particle motion (see also Popper & Hawkins, 2018). Thus, any behavioural criteria should be based on the acoustic signals that the fish can actually detect and respond to. Finally, and perhaps most importantly, a single criterion value for behaviour does not take into consideration the very substantial species differences in hearing sensitivity, behaviour, *etc.*, nor does it take into consideration

response changes with animal age, season, or even motivational state (Neo *et al*., 2014).

11.2 | Recent criteria and guidelines

More recently, a set of interim criteria and guidelines for fishes was developed based on recent scientific advances (Table 2; Popper *et al*., 2014). Of major importance, the authors concluded that it was not possible to define sound exposure criteria for every possible sound source, type of response to the sound, or do an analysis for every fish species (or even all of those potentially listed in various locales). Instead, they developed an approach that focussed on fish groups based on morphology of auditory apparatus (Table 3), on major sound types (*e.g*., pile driving, shipping) and major potential effects (Table 1). The overall intent was to provide the first science-based, but clearly interim, criteria for effects of anthropogenic sound on fishes and to provide a way to deal with the potentially insurmountable combinations of species and sources. The authors very carefully, however, pointed out that the proposed criteria were not complete due to lack of data (Table 2 provides examples of the several effects tables found in the guidelines) and that they expected that as more studies were done, the suggested criteria would evolve.

Finally, the authors of the guidelines made it clear that many of the acoustic impact assessments carried out on fishes in the past and upon which the interim guidelines were based, must be amended since they only considered sound pressure and did not take into consideration the potential effects from high levels of particle motion, something that must be done in future iterations of the guidelines (Hawkins *et al*., 2015; Hawkins & Popper, 2016b; Nedelec *et al*., 2016; Popper & Hawkins, 2018). There is growing international awareness that fishes do possess particle-motion receptors and that this must be taken into account in setting future criteria, once appropriate data are available.

TABLE 3 Grouping of Fishes as per 2014 Guidelines

Group	Characteristics
1	Fishes lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to only a narrow band of frequencies (*e.g*., flatfishes, Pleuronectiformes; sharks skates and rays, Chondrichthyes).
2	Fishes with a swimbladder where that organ does not appear to play a role in hearing. These fish are sensitive only to particle motion and show sensitivity to only a narrow band of frequencies. This group includes salmonids (Salmonidae) and some tunas and mackerels (Scombridae), but many other species are likely to fit into this category as well.
3	Fishes with swim bladders that are close, but not intimately connected, to the ear. These fishes are sensitive to both particle motion and sound pressure, and show a more extended frequency range than groups 1 or 2, extending up to about 500 Hz. This group includes cod fishes (Gadidae), eels (Anguillidae), some drums and croakers (Sciaenidae), and perhaps other fishes.
4	Fishes that have special structures mechanically linking the swim bladder to the ear. These fishes are primarily sensitive to sound pressure, although they also detect particle motion. They have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in groups 1, 2, or 3. The group includes some of the squirrelfishes (Holocentridae), drums and croakers (Sciaenidae), herrings (Clupeidae) and the large group of otophysan fishes.
5	Eggs and larvae.

11.3 | European guidelines for fishes

The monitoring of underwater noise is included in the European Union's Marine Strategy Framework Directive (MSFD; EU, 2008), which is concerned with ensuring good environmental status (GES) of European waters (Andersson *et al*., 2017; Dekeling *et al*., 2016; Tasker *et al*., 2010; Tasker *et al*., 2012; van der Graaf *et al*., 2012). The directive requires that the introduction of energy, including underwater noise, must be at levels that do not adversely affect the marine environment. No specific criteria for fishes are provided but indicators for achieving GES are specified.

The Swedish Environmental Protection Agency recently published a review that discusses regulation of pile driving sounds (Andersson *et al*., 2017). While the review focusses on sound pressure, the authors also strongly concurred with the idea that future guidelines for fishes must also be in terms of particle motion and must also consider signals from the substrate. The proposed exposure values in the document were taken from the Popper *et al*. (2014) guidelines and follow the interim U.S. criteria. The sound pressure levels at which fish are at risk of death or sustaining serious injury to internal organs are considered to be SPL_{peak} 207 dB re 1 μPa, SEL_{ss} 174 dB re 1 $\mu Pa^2\ s^{-1}$ and SEL_{cum} 204 dB re 1 $\mu Pa^2\ s^{-1}$. Thresholds for fish larvae and eggs were based on the fact that no negative effects were observed at exposures of up to SPL_{peak} 217 dB re 1 μPa, SEL_{ss} 187 dB re 1 $\mu Pa^2\ s^{-1}$ and SEL_{cum} 207 dB re 1 $\mu Pa^2\ s^{-1}$. However, the paper notes that there are relatively few studies on the early life stages of fish. The Swedish review does not propose noise levels for flight behaviour or a temporary threshold shift (TTS) in fish because, unlike damage to internal organs, both flight behaviour and hearing damage are linked to the species' specific sensitivity to frequency and sound intensity. And using the existing literature, it is not possible to assess whether flight behaviour negatively affects the species at the population level or whether the effect is related to the area and period of time.

In the UK, Nedwell *et al*. (2007) proposed a set of guidelines for behavioural responses utilising what they referred to as the dB_{ht} (species) concept. Nedwell *et al*. (2007) suggested that specific dB_{ht} levels above the hearing threshold of a fish elicited particular responses. The dB_{ht} is based on a frequency weighting approach since animals do not hear equally well at all frequencies within their hearing range. Frequency weighting is therefore often applied in assessing the effects of sounds upon particular species (*e.g*., Houser *et al*., 2017). Weighting takes account of hearing ability by referencing sound levels to the species' hearing thresholds. The Nedwell approach has been utilised within the UK for assessing the effects of anthropogenic sounds on fishes and it appears to have the tacit approval of some UK regulatory agencies. However, the dB_{ht} approach has very serious flaws that make it totally unacceptable (Hawkins & Popper, 2014, 2016b). This is suggested since Nedwell *et al*. (2007) concluded that strong avoidance responses by fishes start at a level about 90 dB above the dB_{ht}

(species) thresholds, while different proportions of fishes respond at lower weighted levels. However, there are very few field data derived from wild fishes to support these chosen levels. Also, the concept of dB_{ht} has not been accepted in any independent peer-reviewed publications. Indeed, extreme caution must be exercised in applying the dB_{ht} (species) measure. Defining response criteria applicable to all species is a far too simplistic an approach to evaluating behaviour. Moreover, the data on hearing thresholds used for the dB_{ht} approach should ideally be based on accurate behavioural threshold determinations rather than measures of inner ear responses, as the latter are susceptible to flaws (Sisneros *et al.*, 2016).

12 | MAJOR RESEARCH GAPS AND RESEARCH RECOMMENDATIONS

In order to develop better guidelines and criteria, it will be critical to fill many gaps in understanding of the potential effects of anthropogenic sounds on fishes. The goal must be to increase knowledge in those areas that are most likely to enable sound exposure criteria to be revised, as per the expectation of the 2014 guidelines (Popper *et al.*, 2014). There are many research gaps suggested earlier in this paper and in other publications (Normandeau, 2012a,b; Hawkins *et al.*, 2015). Here we will focus on those questions and data needed to move forward most rapidly.

12.1 | Selection of species

It is clear, based on the diversity of fishes and their life styles that it is critical to obtain data from multiple species and a range of sizes and ages of fish within each species. There is likely to be substantial variation in potential effects depending on differences in anatomy, physiology and behavioural responses to various stimuli. Recent guidelines (Popper *et al.*, 2014) suggested dividing fishes into several morphological groups that relate to the presence or absence and configuration of the swimbladder (see Tables 2 and 3). Having a representative set of species or fish types will be critical for future work on all aspects of effects of anthropogenic sound on fishes.

12.2 | Behavioural responses

There is general consensus that the single most important issue is the effects of anthropogenic sound on fish behaviour. While questions about physical and physiological effects are important, the distance around the source that includes sounds of sufficient level to physically harm the fish is relatively small compared with the much greater area that is potentially ensonified, where the sounds are heard by the fish and where behavioural responses may be shown. Far fewer animals are likely to be directly harmed by sounds compared with the number of animals that may show changes in behaviour. Any anthropogenic sounds that alter the ability of animals to hear natural sounds that are important to them (*e.g.*, as a result of masking), or cause temporary loss of hearing sensitivity (TTS), may affect their natural behaviour adversely. Some anthropogenic sounds may frighten the fish away from preferred locales or from migration routes. While many behavioural effects are likely to be minimal and have little or no effect on fish fitness and survival, some behavioural responses may have substantial short and long-term effects upon them.

The currently available data on behavioural responses, as shown earlier, are highly variable and have many problems that do not even start to provide any general principles on how fishes respond to anthropogenic sound. Moreover, there are numerous additional behavioural issues that need to be examined, from the sound levels that are likely to influence hearing (*e.g.*, hearing studies, studies of hearing in the presence of maskers) to responses to sound pressure *v.* responses to particle motion (Popper & Hawkins, 2018). Data are needed on general behavioural responses to sounds at different sound levels and how these responses change over time after the introduction of an anthropogenic source, as fishes may habituate to the sounds or temporarily show hearing losses due to the presence of persistent sounds. Especially significant is what fishes do when they are exposed to a particularly intense sound (do they move away or stay in place) and what are the long-term consequences for fish populations?

Most importantly, long-term, realistic field studies are needed on the effects of anthropogenic sounds on the behaviour of fishes, taking account of cumulative and synergistic effects, along with stress indicators. It is important to carry out such studies in the wild, where there are no constraints like tank walls or netting and where the acoustics are normal.

12.3 | Effects of particle motion

It is now clear that fishes are primarily detectors of particle motion and relatively fewer species of fish use sound pressure. Thus, criteria and guidelines must be developed in terms of particle motion as well as sound pressure. Yet, very little is known about hearing sensitivity to particle motion and it is imperative that such data be obtained. Concurrently, it is imperative to measure the signal from anthropogenic sources in terms not only of sound pressure, as now done, but also in terms of particle motion.

12.4 | Development of dose–response data

Studies on physical effects of pile driving signals in fishes are needed that could lead to understanding dose–response relationships of different sound variables such as signal intensity, number of strikes, inter-strike interval, *etc.* Indeed, a recent study (Casper *et al.*, 2017) suggests that the dose–response relationship is more complex than previously thought. Studies of dose–response relationships will provide insight not only for understanding the onset of physical effects or behavioural effects, but also for determining those levels above the onset level at which potentially harmful effects start to occur. Such information will enable regulators and others to be able to make better decisions on criteria, particularly if they are willing to accept the idea that just because there is a small effect, this may not affect the fitness of the animal.

12.5 | Hearing

Though here is a body of literature on the hearing of perhaps 100 fish species (Ladich & Fay, 2013), the greater portion of these data were obtained using sound pressure measures and do not reflect the fact that most fishes primarily detect particle motion. Moreover, most of the studies (particularly recently) used physiological measures (most often auditory evoked potentials; AEP) that do not reflect the sound processing capabilities of the whole auditory system and thus, do not reflect the actual hearing capabilities of an animal (Sisneros & Rogers, 2016). In order to understand fish hearing and the sounds that potential will affect behaviour, future studies must include particle motion and be done using behavioural methods that reflect how fishes actually respond to sound. Moreover, future studies need to be done in acoustic environments where sounds can be fully calibrated, such as in open bodies of water without physical constraints to reflect sounds, or in specially designed (and very expensive) tanks.

12.6 | Population studies

In contrast with marine mammals, where populations are small and there is concern for single animals, the greater interest for fishes is with populations of animals. Loss of an individual due to exposure to anthropogenic sound does not have the same implications for a species as does the effect on a population. Effects are the broad range of potentially measurable changes that may be observed in individuals, groups of animals, or even habitats as a result of sound exposure. Impacts are effects that, with some certainty, rise to the level of deleterious ecological significance (Boehlert & Gill, 2010). Thus, the effect does not indicate the significance, whereas the impact deals with the severity, intensity, or duration of the effect upon animal populations and ecological communities. Such impacts can then be compared with those resulting from other stressors, including chemical pollution, fishing, pathogens, climate change *etc.* The ecosystem-wide consequences of exposure to sound also need to be evaluated. Effects may influence the dynamics of predation and other types of biotic interactions at the community level. Making assessments across species and communities and within the wider ecosystem, may be of considerable value.

13 | CONCLUSIONS

There is increasing concern about the effects of anthropogenic sounds upon aquatic animals, including fishes. It is evident, however, that there are major gaps in our understanding of the effects of these sounds and especially their effect upon animal populations and aquatic ecosystems. Much of the literature is limited in quality and many of the experiments have been carried out on captive fishes under laboratory conditions, rather than on free-living fishes in the wild. There is also a lack of information on the responses to particle motion, rather than sound pressure. It is evident that there are so many information gaps that it is almost impossible to come to clear conclusions on the nature and levels of anthropogenic sound that have potential to cause changes in animal behaviour, or even physical harm. There is need to carry out further research on the behavioural responses of a range of fishes to different sound sources, under different conditions. As well as investigating responses to sounds of short duration, information is also required on responses to continuous or repeated exposure. What are the immediate effects of sound exposure and what are the longer-term effects in terms of fitness and likely effect on populations?

At the same time, since there is an immediate need for updated criteria and guidelines on potential effects of anthropogenic sound on fishes, we recommend, as do our colleagues in Sweden (Andersson *et al.*, 2017), that the criteria proposed by Popper *et al.* (2014) should be used. (We recognise that the suggestion of using the 2014 guidelines is potentially self-serving since we are lead authors on that document. However, as this document is growing in acceptance, we feel it important that we share our own thoughts and that of colleagues world-wide.) However, as new data become available, these criteria need to be updated and filled in. We also suggest that there is significant need to define what onset of effect means in terms of fishes. Is this, as often now used, the start of any effect even on a single animal, or is it some level that, while easily assessed, reflects some statistical value and which focusses on the population rather than on individuals.

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A.N.P. and A.D.H. contributed equally to all aspects of this review.

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ADOPTED FINDINGS ON COMBINED CONSISTENCY CERTIFICATION AND COASTAL DEVELOPMENT PERMIT APPLICATION

Application No.:	**E-12-005**
Consistency Certification:	**CC-027-12**
Applicant:	**Pacific Gas and Electric Company**
Agents:	Padre Associates, Inc.; DB Neish & Associates
Location:	State and federal waters offshore San Luis Obispo County.
Project Description:	Conduct high energy seismic survey operations in state and federal waters between Cayucos and Point Sal and temporarily install and operate an array of seismic activity monitoring devices onshore.
Commission Action:	Denial/Objection
Prevailing Commissioners:	Commissioners Bochco, Brennan, Burke, McClure, Sanchez, Stewart, Wickett, Zimmer, Vice-Chair Kinsey, and Chair Shallenberger.

SUMMARY OF COMMISSION ACTION

Pacific Gas and Electric Company (PG&E) submitted a coastal development permit application and a consistency certification for the first phase of a potential two phase series of high-energy three-dimensional seismic imaging surveys ("seismic surveys") employing acoustic pulse-generating air guns to study active faults offshore and adjacent to the Diablo Canyon Power Plant (DCPP). The survey would occur in state and federal waters offshore of San Luis Obispo County between Cambria and Pismo Beach.

The seismic surveys rely on the use of air guns to generate high energy acoustic pulses capable of passing through ocean waters and penetrating from six to nine miles into the seafloor.[1] The survey would be carried out by a 235-foot research vessel—the National Science Foundation's *R/V Marcus G. Langseth* —towing two arrays consisting of 18 40- to 360-cubic-inch air guns with a combined total discharge volume of 3,300 cubic inches. The array would be towed at a depth of approximately 30 feet at a speed of 4 to 5 nautical miles per hour. The air gun array would generate an acoustic pulse of approximately 230 to 252 decibels at the source (dB re 1 µPa at one meter) every 11 to 20 seconds. The air gun array would be towed approximately 460 feet behind the research vessel. The research vessel would also make use of two shallow imaging devices, a multi-beam echosounder sonar device and a sub-bottom profiler.

In order for the acoustic pulses created by the air guns to generate sub-surface imagery, the *R/V Langseth* would tow four "streamers" – each one approximately 3.7 miles long and spaced 300- to 500-feet apart. Each "streamers" would be comprised of a cable supporting a series of seven hydrophones capable of detecting the air gun generated acoustic pulses after they penetrate into the each and reflect back to the surface. The rate and manner in which these reflected pulses are detected by the hydrophones allows computer generated images to be created of sub-surface geological formations. The proposed phase one geophysical survey would be carried out in a single survey area, known as "Box Four." Box Four would cover approximately 130 square miles offshore of Morro Bay and be comprised of 880 miles of survey lines. PG&E proposes to conduct the survey between mid-November and the end of December 2012, with the period of active air gun operations limited to approximately 17 days (9.25 days of surveys + 2 contingency days + 5 days of equipment calibration and testing).

The key Coastal Act issue of concern is this project's significant and unavoidable impacts to marine resources. Seismic surveys are among the very loudest anthropogenic underwater sound sources and can cause disturbance, injury, and loss of a large number of marine species due to air gun noise. Of particular concern are impacts to the harbor porpoise (Morro Bay stock), whose range is limited to the general project area, and the entire population of which is likely to be subject to behavioral harassment. The project would also adversely affect Marine Protected Areas, fish and other invertebrates, involving both physiological impacts as well as economic impacts to commercial and recreational fishing by precluding fishing and potentially affecting fish behavior and biology. While PG&E proposes to fund a monitoring program and implement measures to minimize effects, including cessation of air gun use if marine mammals are near

[1] A more detailed discussion of how air gun technology works can be found at: http://www.dosits.org/technology/observingtheseafloor/airgun/

enough to the sound source to be subject to greater than behavioral effects, a number of limitations (including the proposed use of air guns at night time and in potentially high seas and windy conditions that would make it difficult to detect marine mammals) would cause these measures to be ineffective much of the time.

Thus, even with extensive monitoring, and implementation of measures to minimize impacts, the Commission believes this project would still result in significant disturbance, injury and loss of marine biological resources and is therefore inconsistent with the Coastal Act's marine resource protection policies (Sections 30230 and 30231). However, because the project is meant to extend the operational life of a coastal-dependent industrial facility, it qualifies for special consideration under the Coastal Act's coastal-dependent industrial[2] development "override" policy (Coastal Act Section 30260). Section 30260 provides that if a coastal-dependent industrial development such as the proposed survey is inconsistent with any Chapter 3 policy of the Coastal Act, the Commission may nonetheless approve such development if it finds that the proposal meets all three tests of that policy: (1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible.

In applying the first test, the Commission assessed whether alternative survey locations or configurations could provide a feasible and less environmentally damaging way to obtain the expected seismic data. Under the Commission's CEQA obligations, the Commission additionally evaluated a reasonable range of alternatives that might avoid or reduce the project's significant adverse environmental effects. Because the survey's adverse effects are largely related to the extent and duration of survey activities, the Commission focused its assessment of alternatives on whether PG&E could obtain the necessary data using methods that would decrease the extent and/or duration of those activities. Alternatives considered included (1) using alternative equipment, such as seafloor geophones that would reduce the number or length of high-energy survey lines; (2) conducting more extensive analysis of the data collected during previous seismic surveys to either eliminate the need for the current survey or reduce its size or duration; (3) completing the evaluation of PG&E's 2011 and 2012 collection of 2D onshore seismic data and offshore low-energy 3D seismic data, and using those data to reduce and more precisely target areas that may need to be the focus of a future high-energy offshore survey; and (4) using alternative survey techniques – e.g., a different streamer configuration, marine vibroseis, etc. – that might reduce the extent and duration of impacts. The Commission also evaluated "no project" and "no project at this time" alternatives in recognition of the ongoing data collection and analysis by PG&E, the Nuclear Regulatory Commission, and U.S. Geological Survey, which may also serve to more precisely target any future needed survey work.

In assessing these alternatives, the Commission determined that there was insufficient information available to the Commission at this time to conclude PG&E's proposed project is the least damaging feasible alternative, due largely to the need to complete ongoing data acquisition and analysis that may allow for a reduced survey or no survey and other deficiencies in available

[2] The Commission has previously determined that the DCPP is a coastal-dependent industrial facility because it requires seawater for cooling and therefore requires a site on or adjacent to the sea in order to function at all. The proposed seismic survey is meant to gather additional seismic data as part of PG&E's effort to re-license, and therefore extend the operation of, the DCPP.

information. Regarding the use of alternative equipment, the Commission determined that PG&E has not provided sufficient information to show that additional geophones are infeasible or less environmentally damaging. Although PG&E stated that its evaluation showed additional geophones would not reduce the number or length of survey transects, PG&E did not provide that evaluation to the Commission. Regarding the additional analysis of previously-obtained data, while PG&E has conducted some re-assessment of those data, most of that re-assessment was done at least a decade ago and appears to have covered only part of the available data. The Commission therefore believes additional analysis of the full set of available data using updated techniques may result in the opportunity for a smaller or shorter proposed survey.

Regarding the evaluation of the more recently-acquired data, the Commission notes that these data were collected as part of a coordinated seismic characterization effort that includes the currently proposed survey. During the past few months, PG&E has already modified its proposed survey in response to evaluating some of this recently-acquired data, and the Commission believes the currently proposed survey could be further reduced based on completing the full analysis of the recent data. Regarding the use of alternative survey techniques, the proposed project is subject to an investigation funded by the CPUC to independently evaluate the feasibility of alternative streamer and vessel configurations for conducting the survey. This independent review, which has not yet been completed, may lead to further reductions of the proposed survey extent or duration. However, without the results of this review, the Commission does not have sufficient information to determine whether the currently proposed survey is the least environmentally damaging alternative. Finally, regarding the "no project" or "no project at this time" alternatives, it appears premature to conduct the currently proposed survey during the fall of 2012, as other ongoing data collection and analysis efforts by PG&E, the NRC, and USGS are likely to provide even better seismic characterization of the DCPP area in the near future and thereby potentially reduce the need, extent, or duration of the proposed survey.

Based on the above, the Commission finds that the proposed project does not meet the first test of Section 30260, since there is insufficient information to determine that alternative locations are infeasible or more environmentally damaging. The Commission further finds that it has insufficient information to find that the proposed project meets the second and third tests of Section 30260.

The second test of Section 30260 involves public welfare considerations, and the question of whether *not* authorizing the project to proceed "would adversely affect the public welfare." In weighing the public welfare considerations, the Commission finds that the project's impacts on marine resources would be adverse and significant, for the reasons discussed in the body of this report, whereas the benefits to be gained from performing the surveys remain unclear. Therefore, given the evidence provided to date, the Commission is not convinced as to the benefits to be derived from the survey information, whereas the project's impacts to marine resources would be adverse and significant. The Commission therefore concludes that it has insufficient information at this time to determine that not authorizing the project would, on balance, adversely affect the public welfare, and thus that it has insufficient information available to find the project consistent with the second test of Section 30260.

The third test of 30260 requires a finding that the adverse environmental impacts of a proposed project have been mitigated to the maximum extent feasible. As discussed in the marine biological resources, commercial and recreational fishing, and public access and recreation sections of this report, the Commission has determined that it has insufficient information to determine whether maximum feasible mitigation measures have been provided. The project is therefore inconsistent with the third test of Section 30260.

The Commission has therefore denied the permit application and **objected** to the consistency certification.

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Note: The Appendices and Exhibits listed below were provided as part of the November 2, 2012 Staff Report, which is available at the Commission's website: http://documents.coastal.ca.gov/reports/2012/11/W13b-11-2012.pdf

APPENDICES

EXHIBITS

I. COMMISSION ACTION, RESOLUTION, AND RIGHT OF APPEAL

A. OBJECTION/DENIAL

On November 14, 2012, by a vote of 0 in favor, 10 opposed, the Commission objected to the consistency certification and denied the coastal development permit submitted by PG&E on the grounds that it has insufficient evidence in the record to determine whether the project will be in conformity with the policies of Chapter 3 of the Coastal Act.

B. RESOLUTIONS

On January 9, 2013, by a unanimous vote of the members of the prevailing side present at the November 14, 2012, hearing, the Commission adopted the following resolutions in support of its November 14, 2012, decision:

> *The Commission hereby denies the Coastal Development Permit for the proposed project and adopts the findings set forth below on grounds that there is insufficient evidence in the record to determine whether the development will be in conformity with the policies of Chapter 3 of the Coastal Act.*
>
> *The Commission hereby objects to the consistency certification by the Pacific Gas and Electric Company finding that the consistency certification lacks information necessary to evaluate the project's consistency with the enforceable policies of the California Coastal Management Program.*

C. RIGHT OF APPEAL

Pursuant to 15 CFR Part 930, Subpart H, and within 30 days from receipt of the Commission's letter notifying PG&E of the Commission's action, PG&E may request that the Secretary of Commerce override the Commission's objection to consistency certification CC-027-12. In order to grant an override request, the Secretary must find that the activity is consistent with the objectives or purposes of the Coastal Zone Management Act, or is necessary in the interest of national security. A copy of the request and supporting information must be sent to the California Coastal Commission and the National Marine Fisheries Service. The Secretary may collect fees from PG&E for administering and processing its request.

II. FINDINGS AND DECLARATIONS

A. PROJECT DESCRIPTION

Pacific Gas and Electric Company (PG&E) is requesting authorization to perform the first phase of a potential multiple phase series of high-energy three-dimensional seismic imaging surveys employing acoustic pulse-generating air guns to study active faults offshore and adjacent to the Diablo Canyon Power Plant (DCPP). DCPP is a two-reactor nuclear power plant located near Avila Beach in San Luis Obispo County with an operating capacity of approximately 2200 MW. DCPP's two reactors have been in operation since 1985 and 1986, respectively, and are currently licensed by the Nuclear Regulatory Commission to continue until 2024 and 2025. If PG&E determines that an additional phase or phases of surveys is necessary, the first of these additional surveys would be scheduled for the fall of 2013 and would require additional review and approval by agencies including the California Coastal Commission (Commission), the California Department of Fish and Game, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service. The coastal development permit application and consistency certification for the proposed project were modified by PG&E on October 1, 2012 to reflect the substantial project revisions and refinements that had occurred subsequent to the initial submittal of these documents to Commission staff.

Three-dimensional seismic imaging is a tool used by geologists and geophysicists to image subsurface geologic formations. On land, vibrations caused by specialized vehicles equipped with tools such as "vibroseis" or "accelerated weight drop" devices are used to send shock waves into the earth where they can bounce off underground rock layers and be detected and recorded by ultra-sensitive instruments at the surface.[3] In water, sound waves produced by pneumatic devices called "air guns," or by other means, are used for a similar purpose. The timing and intensity of these reflections are used to map the location of subsurface structures such as folds and faults. Low-energy 3-D techniques are typically used to image features within roughly a mile of the earth surface while high-energy techniques can image features at depths of up to about ten miles. Sophisticated 3-D seismic surveys are based on a grid of closely spaced survey lines that create a high-definition three-dimensional picture of the subsurface geology. Interpretation of these data provides useful information that can help discern new geologic features and constrain uncertainties associated with known fault zones, including geometry (i.e., fault length, width, and dip), location, and fault activity or slip rate. The effectiveness of the 3-D survey is largely dependent on how well the subsurface geology can be imaged.

Based on geological studies conducted prior to and since construction of DCPP, several fault zones including the Hosgri, Los Osos, San Luis Bay, and the recently discovered Shoreline (which was discovered approximately 0.6 miles offshore Diablo Canyon in 2008) fault zones are known to be in the vicinity of DCPP. However, the specific geometries, lengths, and interconnections of these faults are not fully understood. Data gathered from the proposed survey would improve the characterizations of these fault zones and allow PG&E to refine current estimates of the frequency and intensity of earthquakes that are likely to occur in the area

[3] Such activities have been carried out extensively over the past several decades on land and have never been known to result in activation of faults or induction of seismic events. Similarly, the use of high-energy air gun arrays has also never been known to induce seismicity.

surrounding DCPP. This information may also improve assessments of the potential seismic hazard and ground motion at DCPP.

The phase one survey proposed by PG&E would occur in state and federal waters offshore of San Luis Obispo County between Cayucos and Point Sal (as shown on Exhibit 1) and would require the temporary placement of 90 seismic monitoring devices along the Morro Bay sandspit (Exhibit 2). The proposed onshore monitoring devices would be approximately six inches high, five inches in diameter, and would be buried by hand approximately 12-inches into the sand above the mean high tide line. These devices would be in place for the duration of the proposed surveys, approximately 17 days.

The proposed seismic surveys rely on the use of air guns (pneumatic sound sources that use highly compressed air to create bubbles of pressurized air underwater[4]) to generate a high energy acoustic pulse capable of passing through ocean waters and penetrating from six to nine miles into the seafloor. The survey would be carried out by a 235-foot research vessel—the National Science Foundation's *R/V Marcus G. Langseth* —towing two arrays consisting of 18 40- to 360-cubic-inch air guns with a combined total discharge volume of 3,300 cubic inches. The array would be towed at a depth of approximately 30 feet at a speed of 4 to 5 nautical miles per hour. The air gun array would generate an acoustic pulse of approximately 230 to 250 decibels at the source (dB re 1 µPa at one meter) every 11 to 20 seconds and would be towed approximately 460 feet behind the research vessel. The research vessel would also make use of a multi-beam echosounder sonar device and a sub-bottom profiler. These devices would be in use throughout the proposed survey and would discharge continuous sound pulses of 242 dB (re 1 µPa at one meter) and 204 dB (re 1 µPa at one meter), respectively.

The *R/V Langseth* would also tow four "streamers" – each one approximately 3.7 miles long and spaced 300- to 500-feet apart. The "streamers" would be comprised of cables and each one would support a series of seven hydrophones (devices that detect the acoustic pulses generated by the air gun array as they reflect back towards the surface from underground and transmit them back to the towing vessel for analysis). Each streamer would be towed at a depth of roughly 30 feet and constant depth and spacing between the streamers would be maintained through the use of specialized diverter devices. Exhibit 5 provides a schematic diagram of the proposed air gun and hydrophone streamer configuration.

The proposed phase one geophysical survey would be conducted in a single section, called a survey "box." As shown in Exhibit 1, this box would be comprised of a series of adjacent survey tracks or transects positioned to provide complete coverage of the proposed geologic targets in the area. The proposed survey area, known as "Box Four," would cover approximately 130 square miles and be comprised of 880 miles of survey lines. Given the size of the research vessel and length of the towed streamer array, the end of each transect line includes a wide turning radius. At the beginning of the survey, the *R/V Langseth* would begin moving along the first transect line while starting up a single small capacity air gun termed a "mitigation air gun." At a given point, the larger capacity air gun arrays (composed of 18 active air guns each) would

[4] A more detailed discussion of how air gun technology works can be found at: http://www.dosits.org/technology/observingtheseafloor/airgun/

begin emitting acoustic pulses and would then "ramp-up," starting at a low level and rising to full volume over a specified period. The acoustic pulses would continue as the vessel proceeds along a pre-established transect. Near the end of each transect, the full air gun arrays would be turned off and the vessel would make a turn in order to continue the next track parallel to the previous track. Given the large turning radius of the vessel, turns are anticipated to last between two and three hours. During these turns, the vessel would continue firing the mitigation air gun, generating pulses of 212 decibels, until the turn is complete and the full arrays are initiated once more. PG&E proposes to conduct the survey – including mobilization and demobilization – over an approximately 33-day period between mid-November and the end of December 2012. The proposed period of active air gun operations and surveying would be limited to approximately 17 days during this period. These 17 days would include two contingency days to address the possibility of needing to repeat sections of the survey and a five day period of limited air gun operations carried out in order to test the equipment and confirm and verify the sound propagation modeling used to estimate sound exposure levels and distances. Maintenance and operational delays (such as those caused by weather, equipment failures, or marine mammal shutdowns) would increase the number of active survey days beyond 17. During the most recent operation of the proposed survey vessel off the coast of Oregon in July 2012, mechanical and equipment failures and operational interruptions occurred with a fairly high frequency. However, information provided by the vessel operator, the National Science Foundation, subsequent to reporting of this information suggests that such occurrences are not typical.

B. BACKGROUND

This project can be traced back to Assembly Bill 1632 (also known as AB 1632 and codified as Pub. Resources Code, Section 25303). Among the provisions of AB 1632 is the requirement (Subpart (8)(A) of PRC Section 25303) that the California Energy Commission (CEC), as part of its energy forecasting and assessment activities, carry out a:

> *compilation and assessment of existing scientific studies that have been performed by persons or entities with expertise and qualifications in the subject of the studies to determine the potential vulnerability to a major disruption due to aging or a major seismic event of large baseload generation facilities, of 1,700 megawatts or greater.*

This assessment was required to include an analysis of the impact of a major disruption on public safety, the economy, and the reliability of the State's electrical generation and transmission system. AB 1632 therefore does not explicitly mandate geophysical surveys or require the current proposed project to be completed. Instead, AB 1632 requires that the effects upon the State's electric supplies of a seismic event at the Diablo Canyon Power Plant (DCPP) and San Onofre Nuclear Generating Station (SONGS) be evaluated by the CEC.

In response to this requirement, the CEC released a report which found that an extended shutdown at either DCPP or SONGS would have major economic, environmental, and system reliability implications, and recommended that PG&E and Southern California Edison update the seismic hazard assessments of the nuclear facilities they operate. The CEC report also recommended that PG&E use "3D geophysical seismic reflection mapping and other advanced techniques" to supplement previous and ongoing seismic research programs. In response to the CEC report's recommendations, the California Public Utilities Commission (CPUC) directed

PG&E to complete 3D seismic studies and submit the results as part of the CPUC's review of the Nuclear Regulatory Commission (NRC) license renewal applications for the DCPP (although the current operating licenses for DCPP's generators would not expire for over 12 years and the NRC has determined that it will not issue final decisions regarding renewal until the issue of spent fuel storage is resolved, PG&E has initiated the license renewal process). Neither the CEC report nor the CPUC specified if the 3D seismic reflection mapping efforts they recommended should make use of high-energy sound sources, low-energy sound sources, or both. However, the CPUC supports the proposed project and convened an independent group of technical experts, called the Independent Peer Review Panel (IPRP), to review, evaluate, and report on the seismic study plans developed by PG&E in response to the CPUC directive. As noted in IPRP Report No. 3:

> *PG&E is planning 2-D and 3-D seismic studies and analyses at its Diablo Canyon Power Plant. PG&E plans to perform these studies for on-shore and off-shore areas by using enhanced 2-D and 3-D seismic reflection mapping and other advanced geophysical techniques to explore fault zones in the vicinity of DCPP, as recommended by the CEC AB 1632 Report.*

Additional detail regarding these and other relevant actions and a timeline is provided in Appendix E at the end of this report.

Independent Peer Review Panel

As noted by State Senator Sam Blakeslee, author of AB 1632, in his 2012 testimony to the CPUC:

> *In January 2010, PG&E applied to the Commission* [CPUC] *for funding to perform additional seismic studies per the AB 1632 report. In August 2010, the Commission issued a decision (D.10-08-003) granting $16.73 million for the studies. However, as a condition of the approval, the Commission convened the IPRP and invited the Energy Commission, California Geologic Survey, the California Coastal Commission and the California Seismic Safety Commission to participate on the panel. The panel was convened to "conduct a peer review of the studies including independently reviewing and commenting on the study plan and completed study findings." The purpose of the IPRP is consistent with provisions of AB 42*[5]*, which required the state's regulatory agencies to do more than simply accept PG&E's proposal, but to actively participate in the design of the studies to ensure that the concerns raised by the Energy Commission in the AB 1632 Report, and reaffirmed by the Commission, are addressed by the studies undertaken by PG&E. Per the Commission's own decision, the IPRP is tasked with providing comments on the design of the study.*

The IPRP, after several organizational meetings, first met formally in January 2012 and has had several formal public meetings since, with the latest meeting occurring in October 2012. These meetings have included discussions of the scope, targets, and objectives of the seismic survey program proposed by PG&E as well as presentations of information by PG&E in response to specific questions and requests for clarification by the IPRP. The IPRP and its informal predecessor group have developed four reports describing the status of its review and

[5] AB 42 was vetoed by Governor Schwarzenegger.

summarizing particular issues that it has identified. These reports were released on September 30, 2010, September 7, 2011, April 6, 2012, and September 25, 2012. As described in these reports, much of the discussion and review effort by the IPRP has been directed at the proposed "seismic targets" identified by PG&E and the potential usefulness of the information expected to be gained from the surveys on the seismic hazard evaluation for the Diablo Canyon Power Plant. In addition, as noted in IPRP Report No. 3 from April 6, 2012:

> *The IPRP's discussions of the high energy off-shore seismic surveys in January and February 2012 also focused on the need for detailed review of PG&E's proposed data acquisition and data processing techniques. The IPRP recognizes that the success of these surveys depends on the interaction and quality of data acquisition and data processing. The IPRP has therefore asked PG&E for a copy of their Request For Proposal (RFP) including the RFP for the high-energy off-shore seismic surveys, so that the IPRP can fully understand: 1) how the survey geologic targets have been characterized to potential bidders, and 2) how the specific parameters of the proposed survey acquisition and processing techniques were chosen. The IPRP received copies of the RFPs for the high energy off-shore seismic surveys on March 2, 2012. These RFPs provided needed information on the study approach and major parameters of the seismic studies. However, the members and staff of the IPRP do not have the expertise to review the techniques used in acquiring and processing the data from the high energy off-shore seismic surveys. These techniques are most commonly used by seismic exploration contractors working for the oil industry. The IPRP has suggested that CPUC consider an additional contract to review this aspect of the seismic studies for DCPP.*

While the IPRP identified, in its April 6, 2012 and September 25, 2012 reports, the importance of a thorough review of PG&E's proposed data acquisition and processing plan and the need for additional expertise on the IPRP to carry out this review, this need has not yet been met and this review has not yet been carried out.

IPRP report number 4, dated September 25, 2012, notes that some of its concerns had been addressed, but the lack of independent review of the proposed data acquisition and processing component of PG&E's offshore survey plan continued to be a key piece of information that the IPRP found to be missing. It is also important to note that the IPRP only recently reviewed and commented on the October 1, 2012 revised project design proposed by PG&E in the CDP application and consistency certification currently before the Commission. These comments were provided to the Commission in a letter from the IPRP dated October 25, 2012 and include the following summary of the IPRP's review of PG&E's modified project proposal:

> *The IPRP finds that PG&E has responded to the questions directed to them and has shown that the initial phase of the proposed high energy survey includes an area where important information regarding the geometry and intersections of several faults may be imaged. The IPRP reached consensus that a 3D high energy seismic survey of Box 4 could provide valuable information about the faults that pose the greatest seismic hazard to Diablo Canyon Nuclear Power Plant.*
> *The IPRP did not reach consensus on whether PG&E has demonstrated that the survey currently planned is optimally designed to provide the highest quality data. The IPRP*

> *membership, with one exception, support the proposed testing as designed. IPRP member Bruce Gibson has expressed general concerns regarding the overall survey planning and data processing approach selected by PG&E, and has not received responses that demonstrate to him that the planned survey is state-of-the-art. In the proposal before the Coastal Commission, Dr. Gibson is specifically concerned that, 1) data quality over the most important targets (SE quadrant of Box 4) will be low, and 2) the data collected by the shore-based array will not provide an adequate image of the targeted features.*
>
> *The remainder of the IPRP members acknowledge Dr. Gibson's concerns, but believe that the currently planned survey is appropriate to provide preliminary answers to the primary questions it is designed to answer. The opportunity for additional review of survey design between surveys in 2012 and 2013, whether by an* [Independent Technical Reviewer] *hired by PG&E, or by contracted experts and the IPRP, give the IPRP greater confidence that high energy seismic surveys will yield valuable data to understand the seismic hazards at Diablo Canyon.*

The consensus position of the IPRP expressed in its previous two reports regarding the importance of additional expert review of PG&E's proposed data acquisition and processing methodology therefore appears to have changed somewhat. This change appears to be at least partially in response to an offer of PG&E noted above and further described in the letter to the Commission from the IPRP - PG&E has offered to hire an additional expert, an Independent Technical Reviewer (ITR), as part of its internal Geoscience Department to provide input regarding the adequacy of the proposed data acquisition and processing methodology. However, as noted by the IPRP:

> *The independent review of survey planning, acquisition, and data processing has been a concern of the IPRP as discussed in IPRP Reports No. 3 and 4. Because of these concerns, the IPRP has discussed hiring additional technical experts who would have a similar charge as the ITR assigned by PG&E. The IPRP notes that the level of independence of the ITR is of paramount importance to the quality of the technical review and public acceptance of survey results.*

Based on this discussion, it appears that while the IPRP still supports the independent third party review of the proposed data acquisition and processing methodology, most of its members do not feel that this review needs to be carried out prior to the initiation of survey activities.

Nuclear Regulatory Commission – 10 CFR 50.54(f) Letter

In response to the previous year's earthquake and tsunami related nuclear facility disaster in Japan, the Nuclear Regulatory Commission (NRC) issued a March 12, 2012 letter to the holders of nuclear reactor operating licenses, including PG&E. This letter was also in response to Section 402 of the Consolidated Appropriations Act, Public Law 112-074, which stated that the "Nuclear Regulatory Commission shall require reactor licensees to re-evaluate the seismic, tsunami, flooding, and other external hazards at their sites against current applicable Commission requirements and guidance for such licensees as expeditiously as possible…" This letter (known as the 50.54(f) letter for the section of the NRC regulations which authorized it) requires PG&E and the other nuclear facility licensees:

> *to provide further information to support the evaluation of the NRC staff recommendations for the Near-Term Task Force (NTTF) review of the accident at the Fukushima Dai-ichi nuclear facility. The review will enable the staff to determine whether the nuclear plant licenses under your responsibility should be modified, suspended, or revoked.*

The NRC staff recommendations referred to in this letter include one requesting licensees to "reevaluate the seismic and flooding hazards at their sites using updated seismic and flooding hazard information and present-day regulatory guidance and methodologies and, if necessary… perform a risk evaluation."

As noted by PG&E:

> *To comply with this NRC Order, PG&E is proposing to carry out the seismic survey to better characterize the seismic sources and associated ground motions of the area surrounding Diablo Canyon. Conducting this study will reduce the level of uncertainty associated with the models being used, thereby increasing the integrity of the assessment and reducing the overall "hazard level." The orders issued by the NRC provide a finite timeline in which to take information collected as part of the study and feed it into the NRC re-evaluation process, otherwise the data will be of limited use and will not be available for the review under the 50.54F orders. By March 11th 2015, all operators need to have all seismic sources and related ground motions evaluated by the NRC Senior Seismic Hazard Advisory Committee (SSHAC)* [study process]. *In order to meet this timeline, the seismic survey needs to be completed this Fall. After the data is collected, processing will be completed by December 2013 for use in the SSHAC process, which can take as long as a year or more from start to finish.*

In reviewing the proposed project, Commission staff consulted with staff of the NRC regarding the requirements of the 50.54(f) letter, the submittal deadline for information provided in response to this letter, and the relationship between the proposed project and the NRC requirement for updated information. In email and phone conversations between Commission and NRC staff in September and October 2012, the NRC clarified that it is in no way requiring that PG&E carry out the proposed high-energy 3D seismic surveys. The NRC also noted that the current SSHAC process was initiated by PG&E in 2011 and that it relies on a series of public workshops and groups of independent experts to review existing information, identify key data, and make recommendations on crucial data needs. As recently noted by the NRC on its website:

> *PG&E is now working with a team of independent experts to determine what should be included in its re-analysis for the NRC. The NRC doesn't yet know if that group will also recommend the high-energy offshore surveys, which cannot be done without state approval.*
>
> *If the offshore surveys are done, the NRC expects PG&E will include that information in its earthquake re-analysis. If not, the NRC expects PG&E will nonetheless assemble enough updated information to complete its re-analysis by early 2015. The results of all this work will ensure Diablo Canyon remains ready to safely shut down after an earthquake.*

History of Offshore Seismic Surveys in California
Please see Appendix B for a description of the Commission's review of previous offshore seismic survey projects.

C. CONSOLIDATED PERMIT

Coastal Act Section 30601.3 provides the Commission with the authority to act upon a consolidated permit for proposed projects that require a coastal development permit from both a local government with a certified local coastal program (LCP) and the Commission. This authority is triggered if the applicant, local government and Executive Director (or Commission) consent to consolidate the permit. For the proposed project, the temporary placement of 90 seismic monitoring devices on the Morro Bay sandspit, would take place within the jurisdiction of San Luis Obispo County under its certified Local Coastal Plan – San Luis Obispo County's LCP. On September 11, 2012, San Luis Obispo County, with the consent of the applicant and Executive Director, agreed to consolidate permit action for aspects of the proposed work that would be carried out in San Luis Obispo County's LCP jurisdiction with aspects that would be carried out within the Commission's retained jurisdiction, consistent with Coastal Act Section 30601.3.

D. COMBINED REVIEW

As discussed above, the offshore component of the proposed project would be located in both state and federal waters. As such, the Commission has authority to review this project under both the California Coastal Act and the federal Coastal Zone Management Act. PG&E has therefore submitted to the Commission both a coastal development permit application and a federal consistency certification. The review of these two submittals has been combined into this single staff report and recommendation.

E. NECESSARY INFORMATION

Section 930.63(c) of the federal consistency regulations (15 CFR Section 930.63(c)) requires that, if the Commission's objection is based on a lack of information, the Commission must identify the information necessary for it to assess the project's consistency with the CCMP. That section states:

> *A State agency objection may be based upon a determination that the applicant has failed, following a written State agency request, to supply the information required pursuant to § 930.58 or other information necessary for the State agency to determine consistency. If the State agency objects on the grounds of insufficient information, the objection shall describe the nature of the information requested and the necessity of having such information to determine the consistency of the activity with the management program. The objection may describe alternative measures (if they exist) which, if adopted by the applicant, may permit the proposed activity to be conducted in a manner consistent with the enforceable policies of the management program.*

As described fully in Section N of this report, the Commission has determined that it does not have sufficient information to enable it to determine whether the project is consistent with Chapter 3 of the Coastal Act, because PG&E has not provided the information necessary for the Commission to determine whether there are feasible and less environmentally damaging project alternatives, whether

denial of the project would adversely affect the public welfare, and whether the adverse impacts of the project have been mitigated to the maximum extent feasible. In order to determine the project's consistency with the CCMP, the Commission has requested PG&E provide it with the necessary information identified in Section N of this report, which includes:

- Evaluation of whether placing additional seafloor geophones to collect data would allow the extent or duration of the proposed high energy survey to be reduced.
- Re-assessment using updated techniques of existing seismic data from the area to determine whether the extent or duration of the proposed survey might be reduced.
- Completion of currently-occurring seismic data collection and analysis to determine whether the survey could be reduced by focusing on a smaller or different target area.
- Evaluation of whether the use of alternative vessels or equipment could reduce the survey extent or duration.
- Incorporation of data and analyses from other ongoing seismic characterization programs (e.g., the Nuclear Regulatory Commission's Senior Seismic Hazard Analysis Committee, the U.S. Geological Survey, etc.) that would allow reduction or avoidance of survey activities.
- A third party review of proposed survey data acquisition and processing.

F. OTHER AGENCY APPROVALS AND CONSULTATIONS

San Luis Obispo County
During the preparation of this report, the Commission staff coordinated with San Luis Obispo County Planning staff to address any potential concerns the County might have regarding the proposed project.

California State Lands Commission
The proposed seismic survey requires from the California State Lands Commission (CSLC) a geophysical survey permit pursuant to Public Resources Code section 6826. The CSLC served as the "lead agency" for this project under the California Environmental Quality Act (CEQA). The original project description submitted by PG&E to the CSLC included proposed offshore surveys within an approximately 530 square nautical mile area over an 82 day period from September through December as well as substantial amounts of onshore survey work and the temporary placement of approximately 600 seismic monitoring devices on the seafloor. On March 16, 2012, the CSLC published a draft Environmental Impact Report (EIR) for public review and comment that concluded that the proposed project would result in significant unavoidable impacts in the areas of marine biological resources, commercial and recreational fishing, land use, recreation, air quality, and greenhouse gases. On August 14, 2012, following a public hearing, the CSLC certified the EIR, adopting as the environmentally preferred alternative a reduced project scope that would be limited to three of the four initially proposed survey areas. At the August 14 hearing, the CSLC requested additional information from PG&E and continued the hearing on the issuance of the geophysical survey permit until August 20, 2012.

At the beginning of the August 20, 2012 hearing, CSLC staff presented a revised version of the three area environmentally preferred alternative identified in the EIR which limited active survey activities to only the months of November and December and provided for a second year of survey activities if PG&E failed to complete its proposed work in the two month window

provided in 2012. PG&E noted its acceptance of this temporally and spatially limited project at the beginning of the hearing. At that hearing, and after taking additional public comment, the CSLC approved a geophysical survey permit for the revised project and PG&E committed to fund an independent third party review process to evaluate the survey design and data acquisition methodology proposed by PG&E. In addition, the CSLC adopted a "Statement of Overriding Considerations" to be included in the EIR which concludes that "the benefits of the information expected to be obtained by implementing the Project outweigh and override the expected significant effects." Subsequent to the CSLC hearing, on August 30, 2012, PG&E further revised the project and limited it to only two of the four initially proposed survey areas. On October 1, 2012, PG&E again revised the project and limited it to only one of the four initially proposed survey areas. This revised project is the subject of this coastal development permit application and consistency certification.

The Commission staff coordinated closely with CSLC staff throughout their review process and during the development of the EIR and provided comments on the draft EIR.

California Department of Fish and Game/Fish and Game Commission
Four areas designated as state Marine Protected Areas (specifically, Cambria State Marine Conservation Area, White Rock State Marine Protected Area, Point Buchon State Marine Reserve, and Point Buchon State Marine Conservation Area) are located near or adjacent to the proposed survey area. PG&E estimates that received sound levels within these Marine Protected Areas (MPAs) would vary from approximately 120 dB to 180 dB. Public Resources Code Section 36710 lists the restrictions applied to State Marine Reserves and State Marine Conservation Areas and states that the California Department of Fish and Game (DFG) may permit research activities that would result in the "take" of marine life within both types of MPA. PG&E has requested a Scientific Collecting Permit to authorize the proposed seismic survey.

Although the authority of the Fish and Game Commission is largely restricted to the establishment of policy for DFG and does not extend to the issuance of Scientific Collecting Permits, the Fish and Game Commission can provide recommendations to DFG regarding the issuance of such permits. At a public informational hearing on September 24, 2012, DFG staff presented the Fish and Game Commission with a draft version of the Scientific Collecting Permit it is considering for the proposed project. The Fish and Game Commission discussed the issuance of the Scientific Collecting Permit and recommended that DFG not approve the issuance of the permit if the project would result in adverse impacts to the biological resources of a designated State Marine Reserve or State Marine Conservation Area.

Northern Chumash Tribal Council
During preparation of this report, the Commission staff solicited input from members of the Northern Chumash Tribal Council regarding their history in the project area, the cultural resources they have identified in the project area, and their concerns regarding potential adverse project-related impacts to these resources.

National Marine Fisheries Service
The National Marine Fisheries Service (NMFS) has responsibilities over the proposed project under the Marine Mammal Protection Act (MMPA), the Magnuson-Stevens Fisheries

Conservation and Management Act (MSA), the Endangered Species Act (ESA), and the Fish and Wildlife Coordination Act. PG&E has submitted an application to NMFS for Incidental Harassment Authorization (IHA) under the MMPA. This authorization would allow the non-intentional, non-injurious "take by harassment" of small numbers of marine mammals during the proposed project. To be eligible for such authorization under the MMPA, the proposed "take" must not cause physical injury or death of marine mammals, must have negligible impacts on the species and stocks, must "take" no more than small numbers of those species or stocks, and must not have an unmitigable adverse impact on the availability of the species or stocks for legitimate subsistence uses. Pursuant to Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), any applicant for a required federal permit to conduct an activity affecting any land or water use or natural resource in the coastal zone must obtain the Commission's concurrence in a certification to the permitting agency that the project will be conducted consistent with California's approved coastal management program. The subject consistency certification (CC-027-12) will serve as Commission review of the project under the CZMA. Should the Commission concur with the consistency certification for the proposed project, NMFS would then be able to consider, and if appropriate, issue an Incidental Harassment Authorization to PG&E. NMFS published a preliminary Incidental Harassment Authorization for public review and comment in the Federal Register on September 19, 2012. The comment period for this document closed on October 15, 2012. Commission staff coordinated closely with NMFS staff and scientists regarding potential adverse impacts of the project on marine mammals.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service has responsibility over the proposed project under the Endangered Species Act and is carrying out a consultation with NOAA under Section 7 of the Endangered Species Act and is considering the issuance of Incidental Harassment Authorization for the harassment of southern sea otters in the project area as a result of proposed project activities. The draft version of this Incidental Harassment Authorization was posted in the federal register for a 30 day public comment period on September 26, 2012. In addition, Commission staff has been in coordination with U.S. Fish and Wildlife Service staff regarding potential adverse impacts of the project on the southern sea otter.

National Science Foundation

The National Science Foundation (NSF) owns and operates the proposed seismic survey vessel, the *R/V Langseth*. As the owner of the research vessel, the NSF needs to authorize the use of the vessel for this project and is therefore the lead agency under the National Environmental Quality Act (NEPA). NSF released a draft Environmental Assessment for the project under NEPA in June 2012.

G. MARINE BIOLOGICAL RESOURCES

Section 30230 of the Coastal Act states:

> *Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economic significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and that will maintain healthy*

> *populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes.*

Section 30231 of the Coastal Act states:

> *The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.*

Seismic surveys are among the very loudest anthropogenic underwater sound sources (Richardson et al. 1995). The proposed conduct of high-energy seismic surveys has the potential to adversely affect marine resources and the biological productivity of coastal waters by causing the disturbance, injury, and loss of marine organisms. Specifically, the generation of high-levels of underwater sound has the potential to injure and kill marine mammals, fish, and invertebrates; the towing of four approximately four-mile long cable streamers behind the research vessel has the potential to cause the entanglement of marine wildlife; and the movement of motorized project vessels to and through the project area has the potential to result in collisions with marine wildlife.

Underwater Sound

The generation of high-levels of underwater sound from each proposed 3,300 cubic inch seismic air gun array, as well as the sub-bottom profiler, multibeam echosounder, and 40 cubic inch single air-gun has the potential to disturb, injure and kill marine mammals, fish, and invertebrates.

Fundamentals of Underwater Sound

Four of the primary factors to consider when evaluating exposure to sound are the received sound intensity, pressure, frequency, and duration. Sound intensity is typically measured in decibels (dB). Most sound receivers are sensitive to sound pressure, which is measured in micropascals (μPa), as well as intensity. Received sound intensity, or dB level, is heavily influenced by the medium the sound is traveling through (for example, water vs. air) and the distance between the sound source and the receiver. For this reason, notations of sound intensity levels often include references to the distance from the sound source, and for underwater sound, the typical convention when describing a sound source is to note its intensity level at a distance of one meter (most commonly, x dB re 1 μPa @ 1 meter (m)).

Differences in the movement and behavior of sound passing through air and water results in the use of different standard measurements for each medium. This means that underwater sound levels cannot be directly compared to sound levels in air, without a process of conversion and a consideration of the distance between the receiver and sound source (refer to Appendix C for a more detailed discussion of this conversion process).

For the equipment proposed to be used for this project, the source sound levels would be:

each 3,300 cubic inch air gun array:	252 dB re 1 μPa @ 1 m;
multibeam echosounder:	242 dB re 1 μPa @ 1 m;
sub-bottom profiler:	204 dB re 1 μPa @ 1 m;
single 40 cubic inch air gun:	212 dB re 1 μPa @ 1 m (approx).

An additional factor to consider when evaluating sound exposure is sound frequency (measured in Hz). While humans normally hear sounds ranging from 20 to 20,000 Hz, some animals including dolphins and porpoise, can detect ultrasonic frequencies (greater than 20,000 Hz) and others, including some baleen whales, can detect infrasonic sounds (less than 20 Hz). Sound frequencies for the equipment proposed to be used for this project would be:

air gun arrays:	0 Hz to 188 Hz (dominant frequencies)
multibeam echosounder:	1200 Hz (approximate)
sub-bottom profiler:	350 Hz.

The final important factor is duration – the period of exposure to a given sound level. This period of exposure can affect an individual's perception of (and physiological and behavioral response to) a given sound. Sound durations are usually divided into two categories – continuous and impulse sound. Each of the two 3,300 cubic inch air gun arrays would generate brief (0.1 second) pulses of sound every 11 to 20 seconds (the two arrays would trade off firing) along each of the proposed transect lines and would be characterized as an impulse sound source. While the single air gun would only be activated during vessel turns and would generate impulse sounds similar to those generated by the full arrays, the sub-bottom profiler and echosounder would be in use during both transects and turns. These devices would generate a new sound pulse every second or fraction of a second and are therefore considered continuous sound sources.

Please refer to Appendix C for a more detailed description of the acoustic process, the relevant measurements used to describe sound, and some of the key factors that affect exposure to sound.

Marine Mammals

A wide variety of marine mammals are known to be present in the project area either permanently or seasonally. As noted in the project EIR at least 22 species of cetaceans (whales and dolphins), six species of pinnipeds (seals, fur seals and sea lions), and one species of fissiped (sea otter) are typically present along the central California coast. While the abundance of some of the whale species varies seasonally, many species including seals and sea lions, porpoise, sea otters, and dolphins, are year-round residents. Of the seasonal species, some such as gray whales (both eastern and western populations) are typically present during their predictable migration along the coast (moving southward in the late fall/winter and northward in the spring), while others such as blue whales, humpbacks and sperm whales are typically present during feeding aggregations in the summer months. However, marine mammal presence is difficult to predict and not all species and individuals follow these general trends. Predictions of marine mammal presence and density are typically based on average observations over many years and therefore

may not reflect the actual behavior of all individuals within a species or the variation in abundance or occurrence that may occur in a single year or season. In other words, marine mammal species may be present in the project area even at times when they are not expected based on the average observations of previous years (e.g., PG&E's low-energy geophysical surveys carried out in the project area between December 2010 and February 2011 encountered 12 humpback whales, despite the fact that this species had not been predicted for this area during this period).

Many marine species, including marine mammals, rely on communication and sensing of their environment for a variety of critical life functions (traveling, finding mates or young, foraging, etc.). Although an animal may communicate and sense its environment in many ways and with a variety of different sensory organs, because seawater is relatively opaque to light and chemicals diffuse slowly in it, marine mammals have evolved to rely primarily on sound to sense their environment and communicate. Consequently, increased acoustic noise in the marine environment can have potentially serious implications for the basic life functions of marine mammals.

The project EIR includes a comprehensive discussion of the specific types of adverse impacts to marine mammals that may potentially result from the high-energy sound levels associated with the proposed survey. These impacts include masking, behavioral disturbance, temporary hearing loss, permanent hearing loss, and other physiological effects, including stranding and/or death. The discussion in the EIR draws heavily on a marine mammal technical report developed for the State Lands Commission by Wood et al. (2012) and included as Appendix H of the EIR (available on the Commission website at: http://www.coastal.ca.gov/ energy/seismic/mm-technical-report-EIR.pdf). The Commission will be relying primarily on the methodology, analysis, and conclusions of this report and providing excerpts of key sections in this report. However, because PG&E substantially modified the project described in its CDP application and consistency certification after the development of this marine mammal technical report and certification of the EIR by the State Lands Commission, the Commission staff requested and received updates to the information provided in several of the tables included in the Wood et al. (2012) report, in order to evaluate the modified project. Information from these updated tables are referred to in the discussion below and provided for reference.

The basic process developed to evaluate the likelihood and magnitude of adverse impacts to marine mammals occurring as a result of the underwater sound involves: (1) dividing the impacts into two categories based on severity and level of harm – roughly, death, injury, or permanent hearing threshold shift (Level A) and disturbance causing disruption of behavioral patterns or temporary hearing threshold shift (Level B); and (2) estimating the number of animals that would fall into each category based on the area of ocean exposed to sound levels associated with Level A and Level B impacts and the expected density of animals within those areas. The National Marine Fisheries Service (NMFS) has used this protocol for many years to evaluate and regulate underwater noise- generating activities under the Marine Mammal Protection Act (MMPA)[6]. While the particular impact threshold sound levels selected by NMFS have changed

[6] The MMPA defines Level A harassment as harassment with the potential to injure a marine mammal or marine mammal stock in the wild, and Level B harassment as harassment with the potential to disturb a marine mammal or

over the years, NMFS evaluations carried out recently have considered the Level A harassment exposure threshold for cetaceans to be 180 dB re 1µPa (root mean square (rms), unweighted) (and 190 dB re 1µPa (rms, unweighted) for pinnipeds), and the Level B threshold for all types of marine mammals to be 160 dB re 1µPa (rms, unweighted).

The Commission believes the concept of separating Level A and Level B thresholds is a useful means of evaluating the potential impacts of underwater sound. However, the Commission has also disagreed with and expressed a number of concerns over NMFS' assumptions in the use of this approach over the past two decades – in particular over the assumptions used to establish the sound exposure thresholds for Level A and Level B impacts. Due to the paucity of data, the Commission has questioned: (1) the extrapolation of sound exposure research carried out on only a few select species to nearly all marine mammal species; (2) the extrapolation from conclusions based on studies carried out on animals in captive environments to use for animals in the wild; and (3) the use of a higher sound intensity threshold for pinnipeds than cetaceans. The Commission has also historically called for greater consideration of research carried out over the past decade that suggests that some marine mammal species and some individuals within populations have greater sensitivity to underwater sound and are more likely to be adversely affected by it.

As a result of these concerns, in case-by-case reviews, as well as its comments to the Marine Mammal Commission, the Commission has not agreed with the specific Level A and Level B impact thresholds applied by NMFS in the past; the Commission has found the use of lower, more conservative sound thresholds to be more appropriate for the evaluation of potential noise related impacts to marine mammals (e.g., in Navy consistency determinations CD-037-06 and CD-086-06). While NMFS currently uses lower sound thresholds that are closer to those that the Commission has supported in the past, its continued reliance on a "one size fits all" approach to estimating the number of animals and species that would be adversely affected by underwater sound may not reflect the current level of scientific understanding. Accordingly, the Commission believes that a second set of thresholds that more closely reflect the current state of science should also be considered.

In 2007, an expert panel was convened to summarize the current understanding of marine mammal hearing and behavioral and physiological responses to sound, and to propose new anthropogenic noise exposure thresholds for marine mammals. The work of this panel resulted in a scientific publication by Southall et al. (2007). In the five years since the work of this panel was completed, several additional studies have become available that modify some of the conclusions reached by Southall et al. (2007). The development of the EIR for this project for CSLC provided an opportunity for the work of Southall et al. (2007) to be considered along with this more recent research and used to develop a more refined set of thresholds and approach to estimating impact levels. This new methodology was developed for the EIR by Wood et al. (2012) and includes some modifications to the approach described in Southall et al. (2007). To compare this new approach with the older NMFS approach, the EIR also included impact estimates that were derived using the NMFS thresholds.

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marine mammal stock in the wild by causing disruption of natural behavior patterns including, but not limited to, migration, breathing, breeding, nursing, feeding, or sheltering.

As noted by Wood et al. (2012):

> *The Southall et al. (2007) noise exposure criteria, with some modifications based on more recent scientific data, are considered the current state-of-the-art standard in terms of marine mammal noise impacts. However, the more recent results must be considered and integrated as appropriate, in a current assessment of potential hearing and behavioral impacts. In the U.S., the NMFS has not undertaken a wholesale acceptance of the Southall et al. (2007) exposure criteria as a stated policy for all sound sources, although elements have been used in regulatory decision-making regarding military sonar (NOAA 2009a; 2009b). For impulse noise associated with seismic surveys, NMFS is currently using estimated thresholds derived earlier and incorporated into current regulations. For the CCCSIP Project EIR, we assess the potential impacts according to these current regulatory thresholds, as well as relative to a derivation of those proposed by Southall et al. (2007) that take into account some of the more recent scientific data…*

The thresholds developed by Wood et al. (2012) and discussed in the EIR represent a substantial advancement in the evaluation and estimation of noise impacts to marine mammals and are responsive to previous Commission concerns over the need for precautionary measures to address uncertainty. The Commission therefore finds the use of a dual-threshold approach using the Wood et al. (2012) methodology in combination with the NMFS thresholds to be appropriate for evaluating potential impacts to marine mammals from the project's proposed use of underwater sound. The marine mammal technical report developed by Wood et al. (2012) and included as Appendix H of the EIR provides a detailed discussion of the particular dual threshold approach developed for the EIR and its application (specifically, see Section 3.7 on pages 44-48).

The tables below provide Level A and Level B marine mammal impact estimates calculated by SMRU[7] at the request of Commission staff using the Wood et al. (2012) approach developed for the EIR and based on the October 1, 2012 revised project submitted by PG&E. These estimates include three marine mammal density scenarios, referred to as "base," "upper," and "potential." These three scenarios have been included because marine mammal density is highly variable and difficult to accurately predict for short time periods (on the order of months) in an area the size of the project area. The available marine mammal density data for the project area most accurately predicts average densities over much larger areas and across multiple years. Therefore, the "upper" and "potential" density scenarios were included to address potential sources of underestimation in the base density scenario with a more precautionary approach.

In addition, the table for potential Level B impacts also includes estimates developed by PG&E for the National Science Foundation's June 2012 draft Environmental Assessment and the NMFS September 2012 proposed Incidental Harassment Authorization (IHA) for the project using the NMFS thresholds. PG&E did not develop estimates of Level A impacts because its application to NMFS for an IHA assumed that Level A impacts would not occur in association with the proposed project. PG&E took this approach based on the assumption that marine mammals would avoid the area exposed to sound levels at or above 180 dB, combined with the assumption

[7] SMRU is the consultant group comprised of the Wood et al. (2012) researchers.

that the use of marine mammal monitors and other impact avoidance measures, such as carrying out aerial surveys, would provide additional security if marine mammals did not avoid this area. In addition, under the Marine Mammal Protection Act, IHAs can only be used for relatively short-term activities that may incidentally harass marine mammals. The IHA process cannot be used where incidental take would likely result in serious injury or mortality to marine mammals (i.e., Level A impacts).

Level A Impacts
In its October 17, 2012 submittal of underwater sound impact estimates to Commission staff, SMRU provides the following introduction:

> *The following takes[8] estimates were calculated for box 4 of the CCCSIP using the methods in Appendix H (Marine Mammal Technical Report) of the CCSIP Final Environmental Impact Report. The Level A and Level B takes for cetaceans and pinnipeds are reported in Tables 1 & 2 respectively. Otter takes are reported in Table 3. Given the planned survey timing (Nov 19 – Dec 15), it is considered that upper and potential take estimates are unlikely to occur for Blue whales, Humpback whales and Fin whales. These species are at reduced densities at this time and substantial turnover of animals is unlikely to occur over the time period November-December given typical migration timing/patterns. The grey whale migration will have just started by December 15 and we estimate that 160 animals will have migrated through the study area by that time (Malme et al. 1984; Rugh et al. 1999; Rugh et al. 2001). This represents 0.8% of the estimated population of 19,126.*
>
> *We note that our Injury* [Sound Exposure Level (SEL)] *calculations (Level A) have a temporal component relating to the amount of track line shot and are thus sensitive to reductions in the number of boxes. In contrast, our Probabilistic rms (Level B) calculations are largely area based, with turnover corrections aiming to account for the length of the project. While the removal of box 1, 2 and 3 reduces the total area predicted to be ensonified, given the radii of the predicted disturbance zones (120 and 140 dB rms M-weighted), the relative reduction is small as a consequence, especially given the limits of harbor porpoise distribution offshore and coastally. NMFS Minimum estimates are also largely area based, whereas NMFS Maximum has a temporal component relating to the amount of track line shot.*
>
> ***Table 1** Proposed Project YEAR 1 (Box 4) Level A takes of special status species calculated using Injury SEL and NMFS rms thresholds under three density scenarios. Red cells highlight high magnitude (>100%), orange highlight medium magnitude (50-100%) and yellow low magnitude (10-50%), based on percentage of Residual Potential Biological Removal (PBR)* [see footnote 7]. *Endangered species are denoted in italics. Take estimates have been modified to take account of group-specific behavioral avoidance responses (range 90-99%) whereby animals avoid the area ensonified to the Level A threshold, as well*

[8] Under the Marine Mammal Protection Act, adverse impacts (including harassment) to marine mammals are referred to as "take."

as detection success of animals entering or within the exclusion zone using [Marine Mammal Observers] *and* [Passive Acoustic Monitors].

Species	Residual PBR	Marine Mammal Density Scenarios		
		Base	Upper	Potential
Fin whale	*15*	0.3	0.4	0.9
Humpback whale	*7.7*	0.1	0.2	1.2
Blue whale	*2.1*	0.1	0.2	0.5
Minke whale	2	0.0	0.0	0.0
Short-beaked common dolphin	3,376	2.7	4.1	5.1
Long-beaked common dolphin	151	0.1	0.2	0.3
Small beaked whale species	25	0.0	0.0	0.0
Harbor porpoise	15	2.9	6.5	6.5
Dall's porpoise	257	0.2	0.3	0.3
Pacific white-sided dolphin	178	0.3	0.4	0.5
Risso's dolphin	39	0.1	0.2	0.3
Northern right whale dolphin	43.2	0.1	0.2	0.2
Bottlenose dolphin – CA coastal	2.4	0.0	0.0	0.0
Sperm whale	*1.5*	0.0	0.0	0.0
Harbor seal	1,569	0.8	1.5	1.5
California sea lion	8,766	49.2	61.5	76.9
Southern sea otter	2,800	11.4[9]		
TOTAL		56.9	75.7	94.2

As indicated by the data in the table above, 13 of the 17 marine mammal species known to inhabit the project area are expected to experience harassment with the potential to result in direct physical injury as a result of the proposed project (Level A impacts). The other four species – minke whale, sperm whale, coastal bottlenose dolphins, and small beaked whale species are not expected to experience Level A harassment due to the low anticipated densities of these animals in the project area during the proposed surveys. Under the highest of the three modeled density estimates, the number of animals that would be potentially injured in each species varies greatly, from 77 sea lions, 7 harbor porpoises, and 5 short-beaked common dolphins to between 0 and 1 for species such as the Dall's porpoise and northern right whale dolphin (the model used to generate these impact estimates relies heavily on marine mammal density data which includes tenths of animals so the impact estimates also include fractions). The Commission uses the highest density estimates to assess the potential impacts of the project

[9] SMRU provided this estimate of the number of sea otters that would be exposed to sound levels of at least 180 dB re: 1 µPa rms and approached to less than 100 meters by the project vessel.

due to the uncertainties inherent in the model and in order to analyze the full potential impact of the project. Under the highest density estimates, the underwater sound that would be generated by the proposed project has the potential to cause direct physical harm to approximately 94 individual marine mammals from 13 species.

In the table above, the residual "potential biological removal" level[10] established by the National Marine Fisheries Service is included to provide a population scale context for the various Level A impact estimates. Essentially, the closer the estimated impact level for a particular species is to the potential biological removal (PBR) number, the more severe the impact would be expected to be on the overall population of that species. Among the 13 species for which potential Level A impacts are estimated, there is one – the Morro Bay stock of harbor porpoise – with estimated take levels (seven) that would reach nearly 50% of its residual PBR (15). Based on these estimates, therefore, the project could potentially threaten the long-term survival of the regional population of harbor porpoise by causing the loss of a high proportion of the animals that could be killed before the population falls below its estimated optimum population size. When considering the residual potential biological removal value included above – the adjusted number that takes into account other sources of human caused mortality that have already affected the stock this year – it is important to consider a series of eight harbor porpoise deaths that have occurred in the project area between late-September and late-October. These deaths are currently being evaluated by NMFS and if any of them are linked to human activities, the residual potential biological removal for harbor porpoise would need to be adjusted downward, thus further increasing the potential for the proposed project to cause this stock to fall below its optimum population size.

In addition, a review of the methodology and assumptions made by Wood et al. (2012) in the development of their impacts assessment model suggests that the Level A take estimates provided in Table 1 may be too low. As discussed by Wood et al. (2012) in the Acoustic Take Methodology Section (Section 3.9) of their report, one of the assumptions made in their model is that marine mammal observers would be used to enforce an exclusion zone around the project vessel in order to assure that the air guns are turned off if a marine mammal is observed close enough to the air guns to receive injurious sound levels. This precautionary measure is a standard practice for high-energy seismic surveys and has been proposed by PG&E as an "applicant proposed mitigation measure." However, marine mammals can be difficult to observe at sea, suggesting that the effectiveness of marine mammal observers may vary. Wood et al. (2012) note this and elaborate that:

> *Marine Mammal Observers (MMOs) on the scout vessel and the survey vessel and initially on the aircraft would be used to monitor the exclusion zone. Passive acoustic monitoring (PAM) would also be in operation. A proportion of animals predicted to co-occur within the*

[10] Potential biological removal (PBR) is an estimate of the maximum number of animals that can be removed from a population from human-caused mortality without causing the population to fall below its optimum size. Each year, NMFS releases stock assessment reports for all regional marine mammal populations in the Pacific Ocean that includes calculations of the PBR for each of these populations based on the most recent available data. The residual PBRs used in Table 1 are from the NMFS U.S. Pacific Marine Mammal Stock Assessments for 2011 and are corrected to include the reported annual anthropogenic mortality estimate for each stock. Residual PBR is an adjusted number that takes into consideration the human-caused mortality to the population that has already occurred in a given year.

Level A radii should be detected, causing subsequent power down (or shut down) and reduction in the predicted take estimate.

The proportion of time MMOs are able to observe will vary over the survey. We have assumed a 12 h. visual monitoring day on average (Civil twilight starts at 6.38am, ends at 6.28pm on October 20th in the investigation area). Quantitative values for probability of detection if an animal is within the prescribed exclusion zone (an average of ~1km based on Greenridge and Jasco Applied Sciences models) are not available for most species, and where available, would depend upon sea conditions and visibility, among other factors. Estimates listed in Table 3.11 are qualitative estimates from experienced field biologists working on these species in many areas. Data was derived for an Environmental Assessment conducted in support of NMFS permit #14534 for biological and behavioral response studies in southern California. The estimates are based upon the size of the individual (the larger the animal, the more likely to detect), the size of the group (the larger the group, the more likely to detect), the frequency of surfacing, and the visibility of surface behavior. These estimates for the distance at which sensitive and hard-to-sight species (e.g., beaked whales) are detected also take monitoring for vocalizations into account. Daylight detection probabilities are considered maximums, taking into account the use of MMOs on two vessels and the proposed use of PAM (Table 3.11). Detection probabilities will likely decrease if the survey continues in poor weather, increasing Level A takes. (emphasis added)

In other words, Wood et al. (2012) used data derived from a discussion by experienced field biologists of the limitations of observing marine mammals at sea in order to come up with detection probability estimates for all of the species considered in their analysis. For Dall's porpoise, harbor porpoise, sea lions, and harbor seals, detection probability was set at 50% (primarily based on the small size of these animals); for all other species it was set at 90%. These probabilities were then integrated in the model for daylight observer effectiveness (at night marine mammal observer effectiveness was set at 0).

However, as Wood et al. (2012) correctly notes, these effectiveness estimates would not be accurate for surveys carried out in poor weather. In order to evaluate the likelihood that the proposed surveys would be carried out in poor weather, Commission staff requested information from the PG&E weather station at DCPP regarding the typical sea state, visibility, and weather conditions during the proposed project period. A "Beaufort Scale" is typically used by marine mammal biologists to describe weather conditions. A Beaufort Scale of two (waves of 1-2 feet, winds of 4-7 mph and no whitecaps) is considered by marine mammal field biologist to represent the level beyond which sea state conditions impede the likelihood of successfully observing marine mammals, when present.
A review of the weather data provided by PG&E indicates that 33% of the days in November and 58% of the days in December experience wind speeds that exceed those defined as a Beaufort Scale of two. The wave heights on 99% of the days in both months tend to exceed those defined as a Beaufort Scale of two. Specifically, the wind speed for the months of November and December in the project area exceeds 18 mph and the mean wave heights for these months are 5.6 feet and 6.5 feet, respectively. Taken together, these wind and wave conditions most closely represent those defined as a Beaufort Scale of five, thus significantly

higher than what marine mammal field biologists consider to be conditions in which they can successfully observe marine mammals.

Thus, based on the specific sea state conditions that are expected to be present in the project area during the proposed surveys, the marine mammal observer effectiveness assumptions used by Wood et al. (2012) appear to be overestimates. A recent letter dated October 11, 2012 from the Marine Mammal Commission to USFWS regarding its proposed IHA raised similar concerns, noting that before moving forward with the issuance of its IHA, USFWS should

> *provide additional justification for its preliminary determination that the proposed vessel-based monitoring program will be sufficient to detect, with a high level of confidence, all marine mammals within or entering the identified exclusion and buffer zones—such justification should (1) describe the efficacy of visual monitoring under the expected environmental conditions (including nighttime and potentially adverse weather conditions), (2) describe detection probability as a function of distance from the vessel, (3) describe changes in detection probability under various sea state and weather conditions and light levels…*

Additionally, the potential lack of efficacy of marine mammal observers is further supported by information from the most recent seismic survey carried out by the proposed survey vessel, the *R/V Langseth*, in July 2012 off the coast of Oregon. A recently released marine mammal observer report from this survey indicates that despite implementation of impact avoidance measures (including many of those proposed by PG&E for the proposed survey), humpback whales were repeatedly exposed to sound levels in excess of 180 dB – levels anticipated to result in Level A harassment - despite the fact that such exposures were not authorized and all of the standard precautionary measures were in place to avoid them. As noted in the *Protected Species Mitigation and Monitoring Report for the Cascadia Thrust Zone Structures in the Northeast Pacific Ocean, 3 July 2012 – 6 July 2012, R/V Marcus G. Langseth*:

> *Eleven sighting events totaling 23 animals were observed within the 160 dB safety radius; 15 of these 23 animals were observed to be exposed to received sound pressure levels of 180 dB or greater. The humpbacks were observed to be in groups ranging from one to five animals. Of the 23 animals observed six were identified as juveniles.*

Although this particular survey lasted just two and a half days and was authorized to expose no more than 12 humpback whales to sound levels at or below 160 dB – the Level B harassment threshold – the use of marine mammal observers and passive acoustic monitors appears not to have been effective. As a result, nearly twice the authorized number of humpback whales were exposed to sound levels of 160 dB or greater, including the 15 exposed to sound levels associated with Level A harassment. While the cause of this incident is not yet clear, the report notes that high wind speeds and swell heights were common throughout the survey. These conditions may have contributed to the lack of effective marine mammal monitoring.

Therefore, it appears likely that the Level A take estimates in Table 1 may be somewhat low as a result of the use of optimistic assumptions regarding the effectiveness of marine mammal monitors.

Level B Impacts

Wood et al. (2012) provides the following introductory discussion to aid in the interpretation of the Level B take estimates included in the analysis submitted to the Commission:

> ***Table 2*** *Proposed Project YEAR 1 (Box 4) Level B takes of special status species calculated using Probabilistic Disturbance rms and NMFS rms thresholds under three density scenarios. Red cells highlight high magnitude (Listed species >2.5%, non-listed species >25%), orange highlight medium magnitude (Listed species 1.25-2.5%, non-listed species >15-25%) and yellow low magnitude (Listed species >1 individual, non-listed species 5-15%), based on percentage of minimum population estimate. Endangered species are denoted in italics. Take estimates have been modified to include group-specific behavioral avoidance responses whereby animals avoid the Level A threshold area.*

Impact Threshold Approach	**Minimum population estimate**	**Wood et al. (2012) Probabilistic Disturbance rms**			**NMFS**	
Density scenario		**Base**	**Upper**	**Potential**	**Base**	**Base + 25%**
Species						
Fin whale	*2,624*	56.8	82.0	205.0	5	6
Humpback whale	*1,878*	26.7	44.9	258.1	3	3
Blue whale	*2,046*	28.4	46.4	115.9	3	4
Minke whale	202	1.8	2.8	7.1	0	0
Short-beaked common dolphin	343,990	482.4	736.1	920.1	349	436
Long-beaked common dolphin	17,127	14.8	43.2	54.0	14	18
Small beaked whale species	2,498	33.6	52.0	65.0	2	2
Harbor porpoise	1,478	1028.4	2327.9	2327.9	315	394
Dall's porpoise	32,106	196.2	329.7	412.1	16	20
Pacific white-sided dolphin	21,406	51.1	78.2	97.8	38	47
Risso's dolphin	4,913	22.0	43.0	53.8	18	23
Northern right whale dolphin	6,019	22.7	32.5	40.6	22	28
Bottlenose dolphin - CA coastal	290	7.4	10.6	13.2	17	21
Striped dolphin	8,231	*	*	*	2	2
Sperm whale	*751*	0.4	0.6	0.8	0	0
Harbor seal	26,667	24.7	48.0	48.0	13	16
California sea lion	153,337	1592.9	1991.2	2489.0	182	228
California gray whale	19,126	*	*	*	17	21

Killer Whale	86/162/346[11]	*	*	*	1	2
Baird's beaked whale	615	*	*	*	1	1
Pygmy and dwarf sperm whale	400	*	*	*	1	1
Sea otter	2,800	*	*	*	352	**
TOTAL		**3590.3**	**5869.1**	**7108.4**	**1019**	**1273**

*-The analysis provided by SMRU does not include estimated impact numbers for these species.
**-Because the U.S. Fish and Wildlife Service (USFWS) has regulatory authority over the southern sea otter, PG&E submitted an application to it for an IHA. The proposed IHA released for comment by USFWS does not include the 25% buffer assumption included in the NMFS proposed IHA.

As shown in Table 2 above, the estimated level of disturbance to marine mammals from the proposed project would be high. Specifically, under the most conservative (i.e., highest) density estimate and using the Wood et al. (2012) thresholds, over 7,000 individual marine mammals from 17 species would be exposed to sound levels sufficient to result in some level of disturbance and behavioral disruption. Among these species are four – fin whales, blue whales, humpback whales, and harbor porpoise – expected to experience "high or medium magnitude" disturbance, as defined by Wood et al. (2012). Wood et al. (2012) uses the high, medium, and low magnitude thresholds to allow the take estimates to be considered in a population context. For the three large whale species federally listed as endangered (fin whales, humpback whales, and blue whales), medium magnitude disturbance is defined as disturbance estimated to affect 1.25% to 2.5% of the total population of the species. For harbor porpoise, the high magnitude threshold is defined as disturbance to more than 25% of the population. However, for harbor porpoise, the estimated disturbance would greatly exceed this threshold, with approximately 200% of the population estimated to experience Level B disturbance (essentially, every individual in the entire population would experience multiple disturbances).

The impact estimates included in Table 2 for the NMFS Level B exposure threshold were calculated by PG&E and provided in its IHA application to NMFS (and subsequently included in the proposed IHA that was released for public comment in late September 2012). Because some of the marine mammals species for which PG&E has requested authorization to harass are federally listed as endangered or threatened under the Endangered Species Act, the NMFS Endangered Species Act Interagency Cooperation Division is currently carrying out a consultation with the NMFS Permits and Conservation Division as well as the National Science Foundation (owner of the seismic survey vessel) regarding the potential adverse effects to these species. This consultation is ongoing and is expected to be completed in mid-November 2012. Although the results of this consultation are not yet available, in personal communications with Commission staff, NMFS Endangered Species Act Interagency Cooperation Division staff has indicated that it has determined that the impact on listed marine mammal species (fin whale, humpback whale, blue whale, sei, and sperm whale as well as Guadalupe fur seals and Steller sea lions) provided by PG&E in its IHA application were calculated in a manner that resulted in potentially substantial underestimations. As such, the NMFS Endangered Species Act

[11] Three stocks of killer whale may be in the area, the minimum population estimate for the eastern North Pacific southern resident stock is 86; the minimum population estimate for the eastern North Pacific offshore stock is 162; and the minimum population for the eastern North Pacific transient stock is 346.

Interagency Cooperation Division is working with the NSF, PG&E, and the NMFS Permits and Conservation Division to re-calculate these estimates for listed species to more accurately reflect the likely impact that would occur as a result of the proposed project.

Gray Whales

In addition to the Level A and B impact estimates derived using the Wood et al. (2012) approach for the marine mammals species included above, the proposed project would also have the potential to adversely affect eastern gray whales. Gray whales are not included in the tables above due to an assumption made by SMRU that active air gun activities would be completed prior to December 15. (Although the analysis by SMRU suggests that 160 gray whales may be present in the area before this date, December 15 is considered to be the beginning of their southern migration in this area and represents the date beyond which substantially larger numbers would likely be present.) However, CSLC has authorized PG&E to operate air guns past this date, and PG&E has indicated to Commission staff in its October 1, 2012 modified project proposal that operations through December 31, 2012 would be carried out if necessary. As such, the following discussion from Wood et al. (2012) of the timing of the southbound gray whale migration and its effect on Level A and B impact estimates for this species should be considered:

> *The Investigation Area co-occurs with the migration route for majority of Eastern North Pacific Stock of gray whales, a population numbering up to 19,126. Southward transit through investigation area is estimated to start mid-December (15th) and peaks mid-January (15th). Small numbers may migrate through area prior to predicted start of migration. The majority of population likely to travel within 3 nautical miles of coast and pass through study area in <24 h. with limited feeding expected to take place. Based on likely sensitivity and (somewhat limited) use of low frequency sounds, gray whales may be more likely than odontocete cetaceans to be affected by seismic noise and they have been shown to exhibit localized avoidance to seismic exploration sound (Malme et al. 1984). However, there is no strong evidence suggesting gray whales are particularly sensitive to seismic or other low frequency noises and responses are expected to be limited and temporary avoidance behavior. Assuming survey is completed prior to the middle of December, then project impacts considered insignificant. Impacts of survey scale to the degree of delay beyond December 15th. High and medium magnitude impact considered Level B harassment to 25% (n=4504) and 15% (2703) of minimum population, may occur approximately 23 and 18 days after predicted migration start (January 2-6th), Direct effects up to day 23, including potential Level A takes, highly unlikely to exceed residual PBR of 233 animals, given responses to noise, typically inshore travel patterns and low likelihood of potential entanglement and oil contamination. May affect and may have substantial adverse effects assessment if survey delayed beyond January 2th. Special mitigation monitoring recommend (initiated only if delayed surveys continue beyond 15th December) to confirm non-blocking avoidance reaction and study prediction of migration transit timing and rate.*

Considering that PG&E has proposed to carry out active air gun operations until December 31, between 160 and approximately 2700[12] gray whales would be likely to traverse the project area

[12] In its October 17, 2012, marine mammal impact assessment submittal to Commission staff Wood et al. indicate that "grey whale migration will have just started by December 15 and we estimate that 160 animals will have

by this date. The project, if carried out during this time, as proposed by PG&E in its October 1, 2012 revised project, therefore has the potential to result in exposure of these whales to sound levels sufficient to cause Level A and/or Level B impacts. A portion of these whales would be pregnant females en route to calving grounds in Baja, Mexico, and may be particularly sensitive to disturbance.

Although virtually indistinguishable physically, gray whales are comprised of two distinct populations, the eastern gray whale discussed above and the western gray whale. While the eastern gray whale is no longer on the federal endangered species list, the western gray whale has an estimated population size of less than 150 individuals, is federally listed as endangered, and is considered to be one of the most endangered marine mammal populations in the world. While the current understanding of the geographic range and migratory routes of this population indicates that it is restricted to the western Pacific Ocean – off the coast of Russia – research carried out in the past several years[13] with the use of satellite tags suggests that this assumption may need to be revisited. Specifically, several tagged western gray whales have been shown to cross the Pacific Ocean and spend fall and winter months off the coast of California and Baja, Mexico. This research has been corroborated through the use of photo identifications of individual western gray whales arriving in Baja in along with the southward migration of eastern gray whales and through the analysis of genetic samples taken of migrating gray whales off the coast of central California. A limited number of western gray whales may therefore be present within the project area in fall and winter months along with eastern gray whales.

As noted in a March 2012 press release from Oregon State University:

> *The long-distance journey of* [the tagged western gray whales – one of which has been named "Varvara"] *is critical because this is the first time scientists have documented that critically endangered western gray whales travel to Baja Mexico, where eastern gray whales frequent. Western gray whales are thought to be genetically distinct from their more populous cousins that are common up and down the West Coast, but Varvara clearly was mingling with eastern gray whales.*
>
> *Mate said there are only about 130 western gray whales in the world and the behavior of Varvara has significant ecological and management implications.*
>
> *"Clearly the experience of Varvara, and Flex* [another tagged western gray whale] *before her, demonstrates that western gray whales can and do come over to the eastern Pacific,"*

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migrated through the study area by that time (Malme et al. 1984; Rugh et al. 1999; Rugh et al. 2001)." Further, in the technical report developed for the EIR, Wood et al. note that Level B impacts to 2703 gray whales may occur by January 2nd. Therefore, the survey activities carried out between the 15th and 31st of December have the potential to result in Level B impacts to between 160 and approximately 2700 gray whales.

[13] This research was conducted by A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences (IEE RAS) and Oregon State University Marine Mammal Institute in collaboration with the U.S. National Marine Fisheries Service, Kronotsky State Nature Biosphere Reserve and the Kamchatka Branch of the Pacific Institute of Geography. The research was contracted through the International Whaling Commission (IWC) and International Union for Conservation of Nature (IUCN) with funding from Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd.

Mate said. "Whether this suggests that they are not a distinct population or that we underestimated their range isn't yet clear."

While the number of tagged whales that have been shown to travel to California is low, the possibility exists that other non-tagged whales may also be making a similar journey. This recent information indicates that western gray whales may also be present in the project area during the proposed surveys and may also experience adverse impacts due to exposure to elevated levels of underwater sound. Based on available information, the probability is low that the proposed project activities would result in exposure of western gray whales to sound levels high enough to cause Level A or Level B impacts. Given the extremely limited numbers of western gray whales that exist, however, even a low probability of such impacts occurring should be considered closely.

Harbor Porpoise
As described above and demonstrated in Table 1 and Table 2, harbor porpoise (Morro Bay stock) would likely be the most severely affected of the marine mammal species in the project area. Wood et al. (2012) provides the following specific discussion of the susceptibility of harbor porpoise to noise related impacts and further elaborates on the impacts anticipated to occur as a result of the proposed project:

Harbor porpoise (Morro Bay stock)
The Investigation area co-occurs with the core habitat of the increasing Morro Bay Stock of harbor porpoises. Considered a resident population (best estimate 2044 individuals, minimum 1478 individuals), with very limited opportunity for emigration, as this stock are not encountered south of Point Conception and the coastal areas north of the Investigation area are considered sub-optimal habitat, with relatively low sighting rates in NOAA surveys. Restricted movement into deeper water (>200m) is also unlikely based on strong coastal habitat preferences (mainly <91m water depth). Time period of survey is post the summer calving period and overlaps with the presumed fall breeding season and therefore considered a sensitive period. Species considered very sensitive to anthropogenic noise effects on hearing (Lucke et al. 2009) and on behavior from a wide range of laboratory and field studies (see Southall et al., 2007). Behavioral responses to seismic noise have been infrequently observed in harbor porpoises (Lucke et al. 2009), and based on their apparent sensitivity to seismic noise in this study and also sounds of various types, there is likely a greater potential for avoidance behavior at large ranges, even given the low frequency nature of seismic air guns.

Injury SEL takes ([2-7] *individuals) resulted in up to low direct impact ratings. Level A takes increase dramatically if assumed behavioral avoidance responses to high intensity noise were reduced, but significantly decreased responses are considered unlikely. Both Probabilistic Disturbance rms and NMFS Level B takes were considered high impact, in all 6 scenarios tested (i.e., both methods at all density scenarios). Probabilistic Disturbance rms takes of* [1028-2328] *individuals equate to* [70]-*100+% of the minimum population estimate…*

> *The porpoise population is considered at high risk to potential for short-term acoustic-related prey disturbances due to residency. Overall, prediction of substantial interference in movement and reduction in core habitat. A large proportion of the population is likely to be affected. The project may affect and likely have a substantial adverse effect through habitat modifications/reduction and combined direct and indirect acoustic effects. Mitigation: Impacts to porpoise are believed largely through Level B harassments which are considered very difficult to mitigate given the ranges over which they occur. Sighting and acoustic detections are typically short-range and are unlikely to extend beyond the exclusion zone. Thus even with mitigation measures proposed the Project likely has a substantial adverse effect on harbor porpoise.*

These analyses and conclusions are supported by NMFS and elaborated on more fully it its proposed IHA. In particular, NMFS raises additional concerns regarding the high energetic requirements of this species and the difficulty it may have on a population level from being displaced from its core habitat and forced to expend large amounts of energy traveling away from the area in order to avoid the air guns. NMFS states:

> *The proposed seismic operations will occur throughout a large portion of the range of the Morro Bay stock of harbor porpoises (i.e., Point Sur to Point Conception, California), and cover much of the core range and optimal habitat for this stock for the duration of the seismic survey. Sighting rates outside of the operational area are much lower, indicating sub-optimal habitat. Studies have shown that harbor porpoises are sensitive to underwater sound and will move long distances away from a loud sound source; and the Morro Bay stock may be forced to move to sub-optimal habitat at the ends of (North or South), or outside their normal range for days to weeks, which may affect foraging success which could in turn have energetic impacts that effect reproduction or survival. This is a coastal species that is primarily found in shallow water within the approximate 100 m (328 ft) isobath and does not move offshore as this is not suitable habitat, and the seismic air gun operations will ensonify a large area that reaches from land to offshore past where harbor porpoises are typically found. This small-bodied species has a high metabolic rate (Spitz et al., 2010) requiring regular caloric intake to maintain fitness and health; therefore, there is a potential for adverse health effects if an animal were forced into an area offering sub-optimal habitat for an extended period of time. The November to December, 2012, timeframe of the seismic operations will avoid the peak of their breeding season and after the first few months that are critical to nursing mothers and dependent calves. The phased approach, as suggested by NMFS and agreed to by the applicant, of conducting seismic operations within the survey boxes (i.e., Survey Box 4 first, Survey Box 2 second in 2012) over multiple years (i.e., Survey Box 1 planned for 2013) has significantly reduced the anticipated energetic impacts within a given year by spreading them over two years. Further, the required monitoring plans will allow us to assess the degree to which, and in part the amount of time, harbor porpoises may be displaced from their core habitat (and potentially crowded into sub-optimal habitat and adjust, in real time L–DEO and PG&E's activity to minimize the likelihood of population level effects...*

To further illustrate the points raised above regarding the proposed conduct of active survey operations within the core habitat of the Morro Bay stock of harbor porpoise, Exhibit 6 includes

a figure demonstrating the location of this core habitat area in relation to the proposed survey areas and a discussion of the genetic and geographic isolation of this stock from the 2011 U.S. Pacific Marine Mammal Stock Assessments developed by NMFS. This figure supports the assessment of Wood et al. (2012) and NMFS that the proposed project will have significant adverse effects on the Morro Bay stock of harbor porpoise. Marine mammal aerial surveys carried out in the project area on October 2, 2012, the results of which are also included in Exhibit 6, further support these conclusions and demonstrate that harbor porpoise are likely to be present within close proximity of the proposed active survey activities. The survey would effectively close about half of the harbor porpoise core habitat area, and porpoises within that area seeking refuge from the survey would likely either move into the remaining core habitat, thereby increasing competition, or move to more marginal habitat areas.

EIR, Applicant Proposed, and Draft IHA Mitigation Measures for Marine Mammal Impacts
To address the anticipated adverse impacts to marine mammals in general and harbor porpoise in particular, the EIR and the NMFS draft IHA describe a variety of directed and PG&E proposed impact avoidance and reduction measures. These measures include some of the standard operating procedures for high-energy offshore seismic surveys as well as several unique measures developed specifically for this project. These measures are described in detail in Appendix D and include: (1) the establishment of a 160 dB safety zone and a 180 dB exclusion zone around the survey vessel; (2) the use of prolonged "ramp-up" periods to slowly increase the sound levels generated by the air guns; (3) the use of marine mammal scans to ensure that no marine mammals are observed within the exclusion zone prior to the initiation of ramp-up; (4) the use of marine mammal observers on the survey and support boats; (5) the use of passive acoustic monitors to augment the marine mammal observer efforts; (6) the use of aerial surveys before and during the project to determine if large concentrations of marine mammals are present within the survey area; (7) the surveying of nearshore tracklines during daylight hours to increase observer effectiveness; (8) and the use of adaptive management in case of multiple marine mammal sightings within the exclusion zone.

While these measures would reduce the anticipated adverse impacts to marine mammals, adverse impacts are still likely to occur. The expected impact reduction from many of these measures was integrated into the Wood et al. (2012) Level A harassment analysis and the results included in Table 1 include this reduction factor. In addition, despite these measures, the EIR concludes that "the overall potential noise-related Project impacts on marine mammals are considered to be *Significant and Unavoidable*" (emphasis in original). Accordingly, the draft IHA further builds on PG&E's proposed marine mammal measures and those required in the EIR and requires additional impact reduction measures for marine mammals, especially for harbor porpoise. These measures are also described in Appendix D and include the development and implementation of a variety of impact assessment and reduction plans. For example, as described in the draft IHA:

> *NMFS coordinated closely with PG&E to develop a comprehensive and precautionary monitoring, mitigation, and adaptive management framework. This plan, which PG&E has agreed to operationally and financially support, is designed to detect significant responses of harbor porpoises to the activity that can be used to trigger management actions in real-*

> *time and allow the activity to proceed in a cautious manner in light of some uncertainty regarding how this species will respond to the activity.*

In addition, the draft IHA also describes the need for a NMFS Morro Bay stock of Harbor Porpoise Monitoring Program, a Southern Sea Otter Monitoring Program, and a Marine Mammal Stranding Response Plan. The analysis included in the draft IHA indicates that the implementation of these plans would be essential to reducing anticipated project related impacts to marine mammals and to allowing the IHA to be issued. As such, Commission staff requested copies of these plans from PG&E. On October 5, 2012, PG&E provided Commission staff with a draft Cetacean Aerial Survey and Passive Acoustic Monitoring Plan, a draft Stranding Response Plan, and a Sea Otter Monitoring Plan. The draft Cetacean Aerial Survey and Passive Acoustic Monitoring Plan and draft Stranding Response Plan were prepared by NMFS staff while the Sea Otter Monitoring Plan was prepared by staff of USGS with input from USFWS and CDFG.

The Commission staff has reviewed these plans and concluded that they have been largely developed to assess the magnitude and range of impacts to marine mammals that may result from the proposed surveys rather than to ensure that such impacts do not occur or are mitigated. While the plans would allow severe impacts, such as large stranding events and significant mortality, to trigger the shut-down of survey operations, given the opacity of the marine environment, if such impacts occur they may remain undetected or be discovered subsequent to the completion of the survey. These conclusions are supported by the NMFS and USFWS staff who contributed to the design of these plans (K. Forney and L. Carswell, personal communications).

While implementation of these plans would undoubtedly provide additional insight on the type of and level of impacts to marine mammals (in particular harbor porpoises and sea otters) that would result from the proposed project, the design of these plans would not provide sufficient information to comprehensively assess all of the impacts that may have occurred to marine mammals. In addition, these plans would not be expected to result in a significant reduction in the anticipated amount of Level A and Level B take of marine mammals associated with the project. Further, PG&E has not provided any clear commitment to carry out compensatory mitigation if the monitoring efforts described in these plans conclusively demonstrate that adverse impacts to marine mammals have occurred. As such, the Commission does not find that implementation of these plans would reduce potential impacts to the Morro Bay stock of harbor porpoise to a level that would be less likely to cause significant population level impacts and potentially jeopardize the continued presence and survival of this species in the project area.

The Commission finds that the project's above described effects, including behavioral harassment and potentially injurious physiological harm to large numbers of marine mammals, cannot be reconciled with the requirement of Section 30230 to protect marine resources and the biological productivity of coastal waters. The Commission therefore concludes that the project's noise effect on marine mammals alone would be inconsistent with Section 30230 of the Coastal Act.

Adult and Juvenile Fish

As with marine mammals, many fishes also depend on sound to communicate with one another, detect prey and predators, navigate, avoid hazards, and interact with their surrounding environment. High levels of underwater anthropogenic sound may therefore result in a wide range of potential impacts on fishes, ranging from behavioral responses to death. The occurrence and magnitude of such impacts may vary depending on many things, from the acoustic characteristics of the source to the distance of the fish from that source, as well as the state and motivation of the fish. Close to a sound source, where the intensity is highest, the impact may include death, physical injury, temporary hearing threshold shift, masking, and behavioral responses. As the animal gets further from the source and the sound intensity level decreases, the number of potential types of impacts also decreases. This concept is discussed by Hawkins and Popper (2012) in their review of available research on the effects of underwater sound on fish and invertebrates:

> *Perhaps the most important concern is how man-made sounds alter the general behavior of fishes. It is likely that fishes will respond behaviorally to man-made sounds at lower sound levels than would result in physiological effects. Thus, fish will show behavioral responses to sounds at much greater distances from the source than those which will result in physical injury. Changes in behavior could have a population level effect such as keeping fish from migratory routes (e.g., salmon or American shad). Issues not only involve detection but also questions of habituation and how fish, in general, respond to a fright stimulus.*
>
> *There are very few studies on the behavior of wild (unrestrained) fishes, and these have been only on a few species and the data are often contradictory. This includes not only immediate effects on fish that are close to the source but also effects on fish that are further from the source.*

While a review of those few studies that have been carried out in the wild, as well as the similarly limited set of studies conducted in laboratory environments provides useful insights, it is important to note that extrapolation of the results of these studies on a limited number of species to the full diversity of fish species within a particular area should be approached with caution. Over 32,000 fish species have been identified to date and within these species is an extraordinary diversity in ear structures and other anatomical features, such as swim bladders, that may play a significant role in hearing abilities and sensitivities to adverse impacts from exposure to underwater sound. Additionally, factors such as size, age, behavior at the time of exposure, and surrounding habitat may also strongly influence the susceptibility of individual fish to adverse impacts. Therefore, the observed behavioral and physiological responses of a limited number of species or individuals within a population may not accurately reflect the responses of other species and individual animals.

As described by Hawkins and Popper (2012), several studies have demonstrated that moderate levels of anthropogenic underwater sounds may affect the behavior of at least a few species of fish:

Engås et al. (1996) and Engås and Løkkeborg (2002) examined movement of fish during and after a seismic air gun study - although they were not able to actually observe the behavior of fish directly. Instead, they measured catch rate of haddock and Atlantic cod as a surrogate or indicator of fish behavior. These investigators found that there was a significant decline in catch rate of haddock and Atlantic cod that lasted for several days within the area of active seismic surveys after termination of air gun use. Catch rate subsequently returned to normal. The conclusion reached by the investigators was that the decline in catch rate resulted from the fish moving away from the fishing site as a result of the air gun sounds.

More recent work (Slotte et al. 2004) showed similar results for several additional pelagic species including blue whiting (Micromesistius poutassou) and Norwegian spring-spawning herring. In this study, Slotte et al. (2004) used sonar to observe the behavior of fish schools and reported that fishes in the area of the air guns appeared to swim to greater depths after limited air gun exposure. Moreover, the abundance of animals 30 to 50 km away from the ensonified area increased, suggesting that migrating fish may avoid entering an area of ongoing seismic survey activity…

Most recently, Løkkeborg et al. (2012) have reported similar experiments to those described above, and obtained data that could be interpreted to suggest that some sounds actually result in an increase in fish catch.

In similar studies, Skalski et al. (1992) showed a 52% decrease in rockfish (Sebastes sp.) catch when the area of catch was exposed to a single air gun emission at 186 to 191 dB re 1 Pa (mean peak level) (see also Pearson et al. 1987, 1992). They also demonstrated that fishes would show a startle response to sounds as low as 160 dB, but this level of sound did not appear to elicit a decline in catch.

Wardle et al. (2001) used underwater video and an acoustic tracking system to examine the behavior of fish on a reef in response to emissions from a single seismic air gun. They observed startle responses and some changes in the movement patterns of fish. Startle responses have been observed in several fish species exposed to air gun sounds (Hassel et al. 2004; Pearson et al. 1992; Santulli et al. 1999).

In an evaluation of the behavior of free-swimming fishes to noise from seismic air guns, fish movement (e.g., swimming direction or speed) was observed in the Mackenzie River (Northwest Territories, Canada) using sonar. Fishes did not exhibit a noticeable response even when sound exposure levels (single discharge) were on the order of 175 dB re 1 µPa2·s and peak levels of over 200 dB re 1 µPa (Jorgenson and Gyselman 2009; Cott et al. 2012).

While relevant, the particular studies described above do not adequately inform an analysis of the potential adverse impacts associated with the particular sound levels and activities associated with the proposed project. For example, the seismic survey studies cited above are based on evaluations of air guns and air gun arrays several times smaller in capacity than those associated with the proposed project. Accordingly, the sound levels evaluated in these studies are

substantially lower than the maximum levels that would result from the proposed project. For example, the proposed project would include survey activities in depths of approximately 22 to 400 meters (roughly 100 meters average depth). The configuration of the towed air gun array would place it at a depth of approximately nine meters below the surface, in an orientation that would increase the sound energy directed downward towards the seafloor.

Therefore, when surveying the shallowest areas within the proposed area, the active air gun array would be approximately 10 meters away from the sea floor. Several of these shallow survey areas would be located offshore of Montana de Oro State Beach and adjacent to the Point Buchon marine protected areas (as shown in Exhibit 4). These areas support persistent kelp and surfgrass beds, extensive areas of rocky reef habitat, and other highly diverse, highly productive marine habitats known to support a wide variety of species and age classes of fish. At a distance of 10 meters from the full air gun array, received sound levels would likely exceed 230 to 236 dB (based on the general spherical spreading assumption that sound levels decrease by 6 dB per doubling of distance from the sound source). In addition, the presence of high relief hard substrate reefs in these areas may cause sound waves to refract and reflect in unexpected ways, potentially accentuating received sound levels at distance and reducing typical attenuation rates.

While research demonstrating the effects on fish from these substantially greater sound levels is limited, a variety of studies do provide useful information. Among these studies are several that note that mortality to adults, juveniles, and larvae of several fish species may occur from exposure to sound intensity levels from 220 dB to 240 dB (Larson 1985, Dalen and Knutsen 1986, Holliday et al. 1987, Greenlaw et al. 1988, Turnpenny and Nedwell 1994, Davis et al. 1998, Wardle et al. 2001, McCauley et al. 2003). These sound intensity levels would likely occur within several meters to several dozen meters of the sound source, suggesting that fish within these areas have the potential to be killed or severely injured.

Although some of the studies cited above were carried out on species that may be found within the project area, only one study has been carried out in the area itself. This study, by Pearson et al. (1992), was carried out in Estero Bay and involved the exposure of rockfish species to ten minute intervals of air gun pulses. The discussion of this study in the draft Environmental Assessment notes that:

> *In five trials over four days in Estero Bay, California, Pearson et al. (1992) found sound levels as low as 161 dB caused rockfish (blue, olive, vermillion and black rockfish) to change swimming behavior. Shifts in vertical position (up or down), alarm, and startle responses were also observed. Startle responses are flexions of the body followed by rapid swimming, shudders, or tremors. Alarm responses are changes in schooling behavior that presumably would lead to avoidance behavior. A threshold of about 180 dB elicited alarm responses. A threshold for startle responses for olive and black rockfish was reported as between 200-205 dB. Blue and black rockfish reacted as a group, possibly related to their behavior as schooling fish species. Fish returned to pre-exposure behavior within minutes suggesting that any effects on fishing would be transitory.*

It is unclear, however, based on the results of this study, what effect prolonged exposure of rockfish species to sound intensity levels at or above their observed behavioral response threshold of 161 dB and startle response threshold of 200-205 dB would have.
While the studies cited previously provide data suggesting that at the highest received sound levels (220+ dB) and shortest distances from the sound source, physical injury and mortality to a variety of fish life stages may occur, it is important to recognize the limitations of these studies and the relevance of the information they provide to the currently proposed project. As noted in the draft Environmental Assessment, "Extrapolation of experimental results to actual effects during surveys presents some uncertainties due to differences in duration and intensity of exposure." For example:

> *Christian and Bocking (2010) noted that the Pearson et al. (1992) studies were quite different from an actual seismic survey in that the duration of exposure was much longer. When caged European bass were exposed to multiple discharges with a source SPL of 256 dB, the air guns were pulsed every 25 s over two hours. The minimum distance to the cage was 180 m (590 ft). Although no pathological injury was reported, Santulli et al. (1999 cited in Christian and Bocking 2010) did find higher levels of cortisol, glucose, and lactate, biochemical parameters that indicated more stress than in control fishes. Video data showed slight responses when the air gun was as far away as 2.5 km (1.5 mi). When the array was within 180 m (590 ft) the fish packed densely in the middle of the cage. Normal behavior returned after about two hours.*

In comparison, the proposed project would involve exposure of a wide range of fish species to shorter interval sound pulses (11 to 20 seconds) at both shorter and longer distances from a similar sound source. As such, available research is insufficient to conclusively determine that the proposed survey activities would not cause significant injury to fish populations in nearshore waters. However, the amount of impact that may occur remains unknown and unknowable. Based on a review of available research by Commission staff, it appears that no studies are available that could be used to make a defensible accounting of the magnitude of impact to nearshore fish populations. Essentially, the available research suggests that adverse impacts would be likely to occur immediately below and in the vicinity of the survey but provides no clear indication of the level of these impacts or how they would affect particular fish species.

With regard to the deepwater habitat located throughout the majority of the project area and the potential impacts to the fish species that inhabit these areas, substantial uncertainty also exists. While the depths of offshore areas (typically several hundred feet) would substantially reduce the received sound levels at the bottom compared to the nearshore survey lines, given the high sound source levels associated with the proposed project, even these areas would likely be exposed to sound levels of over 200 dB. Most available research, including that discussed in Appendix E of the project's draft Environmental Assessment, suggests that the most likely impacts to fish in deeper waters would be disturbance. For example, as noted above, the Environmental Assessment described a study carried out in Estero Bay (Pearson et al. 1992) that found that rockfish showed transitory startle and alarm responses after being exposed to sound intensity levels of 200-205 dB.

However, while the results of this study are important to consider – especially because it was carried out in the project area and targeted several of the key fish species located there – it diverges from the proposed project in several key ways. Primarily, this study exposed fish to approximately 10 minutes of air gun sounds while the proposed project would include several weeks of continuous activity within a fairly limited area. While rockfish appear to recover prior behavioral patterns within a short time after limited exposure, it is uncertain how rockfish species, or other pelagic species for which less information is available, would respond to more prolonged exposure.

One set of fish species about which even less is known regarding potential impacts from underwater sound is the cartilaginous fishes, sharks and rays. There have been no studies concerning how underwater sounds might affect these species, either behaviorally or physiologically. However, as noted by Hawkins and Popper (2012), these species have well-developed ears and substantial evidence exists to suggest that they are able to detect and respond to sound, and that sound plays a major role in their lives (Myrberg 1978, 1990, 2001; Casper and Mann 2009; Casper et al. 2012). Studies of hearing show that sharks and rays detect sounds from below 50 Hz to over 500 Hz (a range that overlaps with the dominant sound frequencies used by air guns) even though they have no swim bladder or other gas bubble associated with the ear. Since they have no internal gas chambers, the likelihood of physiological effects from other than the most intense sounds is substantially lower than for fishes with gas bubbles, but there are likely to be behavioral effects associated with masking and, perhaps at high chronic sound levels, Temporary Threshold Shift (TTS).

To address the recognized uncertainty regarding the magnitude and extent of adverse impacts to fish species as a result of the project, PG&E has proposed to carry out several monitoring efforts in the project area focused specifically on fish and fish catch rates in offshore areas. PG&E describes these efforts as follows:

> *Study of the Effects of the Seismic Survey on Fishes. PG&E has agreed to fund a two-component study to examine the short- and long-term effects on fish abundance (and invertebrates) of the seismic survey: (1) Remote Operated Vehicle (ROV) surveys to assess the abundance of common rockfishes and other demersal fish and invertebrate species in sites before, during, and after the seismic survey; and (2) funding the California Collaborative Fisheries Research Program (CCFRP), which is an existing program between the fishing communities of Half Moon Bay, Moss Landing/Monterey, Morro Bay, Port San Luis and the academic institutions of Moss Landing Marine Labs and Center for Coastal Marine Sciences at Cal Poly, San Luis Obispo to study the long-term effects of the HESS on fish abundance in shallower waters.*

As noted by PG&E in the document it developed to describe its fish monitoring program, however, the currently designed monitoring plan has limitations:

> *It is unlikely that sufficient statistical rigor will be achieved by either sampling approach to apply a BACI analysis to the assessment, however the information collected by the ROV will certainly provide some quantitative data from which a qualitative description of observations on the immediate to short-term effects of the* [high-energy seismic surveys] *on these sites.*

Although limited to obtaining "snapshots" of several habitat areas that may not be reflective of the larger project area, the proposed ROV survey would nevertheless provide more information than currently exists regarding the response of fish in deepwater habitat to high-energy seismic survey operations. However, PG&E has not proposed to use the results of these monitoring efforts to carry out compensatory mitigation if adverse impacts are observed. Further, in its current form, the proposed monitoring plan is not designed to be able to accurately or completely reveal those impacts to fish that may occur in the project area.

Adult and Juvenile Invertebrates
Very limited information is available regarding noise related impacts to marine invertebrates – either sessile species such as shellfish, anemones and sponges, or mobile species such as squid, crabs, lobster, and marine snails. As noted by Hawkins and Popper (2012):

> *One question that is very hard to deal with is the potential effect of man-made sounds on invertebrates. There are almost no data on hearing by invertebrates, and the few suggestions of hearing indicates that it is for low frequencies and only to the particle motion component of the sound field (e.g., Mooney et al. 2010, 2012). There are no data that indicate whether masking occurs in invertebrates or to suggest whether man-made sounds would have any impact on invertebrate behavior.*

Appendix E from the draft Environmental Assessment provides the following general review of available research:

> *Christian and Bocking (2010) stated that, "In general, the limited studies done to date on the effects of acoustic exposure on marine invertebrates have not demonstrated any serious pathological and physiological effects." However, an earlier review by Moriyasu et al. (2004) found that nine quantitative studies showed five cases of immediate impacts and four cases of no impact. However, many of the studies lacked rigorous examinations and lacked clear sound measurements. They found that studies reported by La Bella et al. (1996), McCauley et al. (2000) and Christian et al. (2003) contained the most useful information of the possible impacts of air guns on invertebrates.*
>
> *Crab fisheries are a major resource, and much like certain species of fishes, crabs have pelagic larval stages that live offshore in the plankton for several weeks. Pearson et al. (1994) exposed stage II larvae of Dungeness crab (Cancer magister) to single discharges from a seven-air gun array and compared their mortality and development rates with those of unexposed larvae. They found no statistically significant differences in immediate survival, long term survival, or time to molt between the exposed and unexposed larvae, even those exposed within 1 m of the seismic source. Christian et al. (2003) did not detect any effects on the behavior of snow crab placed in cages at 50 m (164 ft) depth and exposed to sound levels of 197-237 dB.*

In addition, the EIR notes that:

> *…studies suggest that seismic survey noise-generation activities in the Project area would have very little effect on benthic invertebrates, which would be insensitive to these sounds.*

For example, Pearson et al. (1994) found sound levels between 222 and 244 dB re 1 µPa had no effect on Dungeness crabs (Cancer magister) within distances of only 3.3 feet (1 m) from an air gun array. Kosheleva (1992) exposed mussels (Mytilus edulis), amphipods (Gammarus locusta), and Periwinkle (Littorina littorea) to a 223 dB re 1 µPa air gun only 1.6 feet (0.5 m) away and documented no injury.

In an in situ study, Wardle et al. (2001) set up cameras and acoustic tags around a natural reef and observed the reef prior to, during, and following exposure to seismic air gun firings with magnitudes as high as 218 dB. No effects on invertebrates were observed.

Based on this available information, it appears that impacts to most invertebrate species would be unlikely. However, recent research focused on the physiological responses of squid and octopus species to underwater sound suggests that these species may be particularly sensitive and susceptible to physical injury. André et al. (2011) exposed four species of wild captured squid and octopus to 157-162 dB sound sweeps at 50-400 Hz for two hours before surgically evaluating them. All exposed animals were found to have suffered significant damage to internal sensory organs. These findings appear to be supported by previous work by McCauley et al. (2000) that observed alarm and startle responses in squid exposed to air gun pulses of between 156 dB and 174 dB. As noted by André et al. (2011), "[i]f the relatively low levels and short exposure applied in this study can induce severe acoustic trauma in cephalopods, the effects of similar noise sources on these species in natural conditions over longer time periods may be considerable."

While the type of sounds used by André et al. (2011) in their research does not exactly replicate the sound that would be produced by air guns, the significant physiological effects that they observed suggests that squid and octopus species may be particularly susceptible to injury from exposure to low-frequency underwater sound. With a maximum anticipated sound source level of 254 dB, the injury threshold for squid, between 156 dB and 174 dB, would extend throughout the project area. Therefore, injury, disturbance, and displacement to large numbers of squid may potentially occur due to the size of the 156 to 174 dB radius from the project vessel – up to about five miles.

In sum, there are many gaps in the scientific data regarding the effect that seismic surveys, such as the proposed project, may have on fish and invertebrates of various life stages. Available data does show, however, that anthropogenic underwater sounds are likely to adversely affect the behavior of fish and could result in mortality for those fish in close proximity to the air gun arrays. Additionally, available research also suggests that some invertebrate species, including squid and octopus, may be susceptible to injury when exposed to even moderate levels of underwater sound. Finally, the proposed project includes the use of air guns that have higher maximum sound intensity levels and will be used for substantially more days than those used in the majority of available studies. Thus, the project is expected to have a significant adverse effect on a wide range of fish and invertebrates, including bony fishes, cartilaginous fishes, and squid and octopus.

Fish and Invertebrate Eggs and Larvae
Although limited information is available regarding the effects of underwater sound on eggs and larval organisms in the water column, the few available studies suggest that larval organisms and eggs in close proximity to a high-energy sound source are likely to experience severe injury and mortality. The draft Environmental Assessment (Appendix E) cited several studies that evaluated the effects of underwater sound on specific species at different distances. These studies used varying sound levels and distances to determine effects on particular species, and, although results were not consistent, they generally suggest that the range in which these organisms are killed or injured are typically in the tens of feet from sound sources of comparable intensity to the proposed air guns. For example, as noted in Appendix E to the draft Environmental Assessment:

> *Eggs and larvae that are closer than 3 m (10 ft) can be damaged by individual air guns, and Davis et al. (1998) calculated that some mortality can occur at a distance of up to 5.5 m (18 ft) from the largest array. They estimated a volume for a zone of lethality as 1,965 m3 per shot, given a typical air gun array of 3,000 to 4,000 in3. Holliday et al. (1987 cited in Davis et al. 1998) found that 2-day old anchovy larvae were more sensitive compared to older larvae and adults (Table 3).*

Table 3. Larval and adult anchovy mortality and damage from 75 to 90 kPa (217-220 dB re 1 µPa 0-peak). Data from experiments by Holliday et al. (1987 cited in Davis et al. 1998).

Stage	Effect	Notes	Peak Pressure[1] (kPa)
Larvae	50% Mortality	2 d old	100
		4 d old	75
Adults (100 mm)	Swim bladder damage	Damage occurred	90
		No damage	40

Based on these studies, the 5.5-meter radius "zone of lethality" described by Davis et al. (1998) is considered an appropriate and conservative threshold for assessing the extent of expected planktonic losses. In response to requests for information from Commission staff and the California Department of Fish and Game, PG&E on September 25, 2012 provided an impact assessment that used the 5.5-meter distance from the air guns as the area within which planktonic organisms would not be expected to survive due to sound exposure. The assessment calculated the volume of water within the project area that would be within this distance of the air guns as they were being fired during the survey. It used data collected from a 1997-99 entrainment study conducted offshore of DCPP to estimate the density and diversity of larvae expected to be within this volume of water, and assumed 100% mortality for the larvae within this water volume. Due to lack of data, PG&E's analysis did not assess the expected mortality of pelagic fish eggs that would result from survey activities, but stated that "the same or somewhat lower mortality rates would apply."

PG&E's analysis concluded that survey tracks totaling 1,608 miles in length would result in roughly 65 billion gallons of seawater being within the 5.5 meter radius "zone of lethality" of the air guns. Based on the results of the 1997-99 DCPP entrainment sampling, the analysis additionally concluded that this volume of seawater would be expected to contain from 8.56 to 9.20 million fish larvae. Accordingly, with the assumed 100% mortality to larvae within this

water volume, PG&E's analysis concluded that the project was expected to cause the mortality of up to 9.2 million larval fish within the project area, along with an unknown number of fish eggs. However, the project evaluated in the September 25, 2012 report from PG&E was subsequently modified and reduced in size PG&E's updated evaluation, provided on October 31, 2012, states that the currently proposed survey tracks would have the full array of air guns firing over a total length of about 576 miles for a total water volume in the "zone of lethality" of about 23 billion gallons (although this does not include operations during turns with only the mitigation air gun firing). Assuming the larval densities are the same for both the previously evaluated and currently evaluated survey track lengths, the expected level of mortality would be about 36% of 9.2 million, or approximately 3.3 million larvae.

The DCPP sampling data show the dominant species represented in this number are northern anchovy, Pacific sardine, kelp/gopher rockfishes, northern lampfish, and blue/olive rockfish. PG&E's analysis concluded that this level of mortality was insignificant when compared to the overall number of larvae from these species within the study area and when compared to natural predation of these species. However, for several reasons detailed below, PG&E's analysis does not adequately support this conclusion and appears to underestimate the project's effects.

Evaluating the effects of removing this amount of larval fish on the offshore ecosystem and on adult fish populations is complex. Three methods are typically used for such analysis – the "Adult Equivalent Loss" (AEL) method, the "Fecundity Hindcasting" (FH) approach, and the "Empirical Transport Model" (ETM) and the related "Area of Production Foregone" (APF), which is derived from the ETM approach. All three methods have been used to determine the effects of larval losses that result from a stationary intake drawing in seawater for a power plant, desalination facility, or similar industrial use, with the APF approach developed most recently to approximate the amount of lost ocean productivity these organism losses represent. ETM is used to identify the proportional mortality of the losses – that is, the number of organisms killed compared to the number of organisms in the source water area that have the potential to be killed. The proportion may be different for each species because each has a different concentration per unit volume of water and has a different source water area because they are susceptible to entrainment during a different number of days or weeks of life stages – for example, a species that grows slowly and cannot swim away from an intake for its first several weeks of life may have a source water area that extends dozens of miles upcoast or downcoast, depending on the speed of the current that carries it towards the intake. This proportional mortality can then be used to identify the APF – that is, the number of acres of different types of ocean or estuarine habitat types needed to replace the productivity represented by these lost organisms. PG&E's analysis, which used a modified version of this approach, is the first analysis known to staff that applies this approach to a mobile array of air guns instead of a stationary intake. While the analysis includes some reasonable assumptions, several questions remain about the appropriateness of the data used and whether the approach used in the analysis accurately characterizes the likely impacts.

- **Appropriateness of Data Used:** Most of PG&E's proposed survey would occur in deep water offshore, but the entrainment data used in the analysis was primarily from shallow areas with different biological characteristics. As noted above, PG&E used sampling data collected in 1997-99 from nearshore waters off of DCPP. Samples were collected from

several transects parallel to the shoreline, with the most seaward transect about a mile from shore. Most of the sampling locations were in areas with water depths of less than 60 meters. Even so, the samples showed distinct differences in the species types and abundance collected in the nearshore and shallower waters and those in the deeper offshore areas. Most of PG&E's proposed seismic survey would occur in areas much farther offshore and with significantly deeper waters than these sampling locations – for instance, roughly two-thirds of the survey area is more than three miles offshore, with depths of more than 400 meters and an overall average depth of more than 100 meters. The biological gradient observed in the 1997-99 sampling showed significant differences between species collected near the shoreline and those collected in areas of about 60 meters depths, suggesting that the community of species that would be affected by the proposed survey would be much different than those used as the basis of PG&E's recent analysis. It is therefore not clear that PG&E's assessment accurately describes the potential impacts to the planktonic community.

Modifying the assessment to include additional data with the 1997-99 nearshore data (i.e., no more than a mile from shore) could provide a better representation of the types and expected abundance of larval species that would be affected by the project. One source of additional data may be the California Cooperative Oceanic Fisheries Investigations program (CalCOFI). CalCOFI has several sampling stations in federal waters offshore of Point San Luis near the proposed project area that could provide more appropriate data on representative larval fish species and density in the project area, which extends up to about 17 miles offshore. It is not clear, however, whether CalCOFI has conducted sampling at these nearby sites during the fall season. If fall sampling data are available, Commission staff recommends that it be incorporated into the analysis. Given the seasonal variability in larval fish diversity and abundance in the water column, offshore samples from spring and summer seasons may not accurately represent the species types and numbers present during the proposed survey period; however, PG&E could review those spring/summer sampling data to determine the degree of correlation to the DCPP sampling data, which may allow partial inclusion of the offshore CalCOFI data to improve the analysis.

- **Appropriateness of Approach Used:** PG&E's analysis used the upper 100 meters of water within the survey area as the basis for the expected project impacts. By doing so, the analysis substantially underestimated the proportional mortality that would result from the survey, and thereby discounted the significance of the survey's potential effects. The analysis assumed that larval mortality would be limited to areas within 5.5 meters of air guns that would be towed at a depth of about 10 meters; therefore, the area of the water column within which larvae would be subject to mortality would be no more than about the uppermost 16 to 20 meters. However, rather than use this upper part of the water column as the source water area, the analysis based its proportional mortality calculations on the upper 100 meters of water within the survey area. By including these substantial volumes of water within which plankton are not likely to be affected, the analysis significantly underestimated the proportional effects on the various species. Further, any diurnal differences in the composition of the plankton community – i.e., detecting species that emerge from or descend to deeper waters during the day or night – are already included in the data, since samples were taken over 24-hour periods. It is therefore not necessary to include the deeper parts of the water column in the analysis.

> Conducting the analysis using just the top 20 meters of the water column as the source water area would substantially increase the expected proportional mortality of the survey – that is, the larvae affected by the survey would represent a larger proportion of the total larval population in the top 20 meters of the survey area than the total population living in the entire 100+ meter depths of the water column. Even though larval densities are generally higher in the upper water column than the lower, recalculating the source water area using just the top 20 meters is likely to significantly increase the proportional mortality and the overall effect of the survey on the planktonic community.

While modifying PG&E's analysis to address the above concerns would likely improve the impact assessment, there would remain a substantial degree of uncertainty. The estimates of expected plankton mortality due to in-water sound are based on a limited number of studies, most of which were done in other areas and on species not present in the survey area. For example, available studies discuss effects on local northern anchovies and Dungeness crab, but also Atlantic cod and species offshore of Nova Scotia and Norway or in the Black Sea. As noted in the project's Environmental Assessment (see Appendix E, page 3 of Addendum 1, "Responses to Issues Raised During a November 2, 2011 Meeting with Fishers at Port San Luis", PG&E states: "There are a number of other gray literature studies of the effects of sound on developing eggs and larvae; none provide conclusive evidence on this topic that is germane to most Pacific Coast species. Indeed, one can conclude that there is a total dearth of material on this topic and it is an area of research that needs rigorous experimental evaluation. In summary, the few studies on the effects on eggs, larvae, and fry are insufficient to reach any conclusions with respect to the way sound would affect survival. The level of uncertainty might be reduced by using additional assessment methods, such as the above-referenced AEL and FH methods, which calculate the effects of plankton losses on adult fish populations. However, these methods have been used primarily to determine effects on commercially-important fish species, and rely on having extensive knowledge about the affected species' life history, which is unavailable for most species in the survey area. These methods are not as useful for identifying the effects of planktonic losses on food web dynamics, community structure, or other similar ecosystem functions. Additionally, and as noted above, there are apparently no studies describing the lethal or sub-lethal effects of the project's air guns on fish eggs, so this would remain an area of uncertainty.

Based on the data used by PG&E and the assessment provided, it is likely that the survey would result in mortality to about 3.2 million fish and invertebrate larvae in the project area and an unknown number of fish eggs. The proposed project does not include measures to mitigate for this adverse effect. Further, given the paucity of relevant data and studies, as well as the questions about the suitability of the submitted assessment in accurately characterizing likely effects, it is not clear that the extent of this adverse effect, or its significance, has been adequately assessed. Nonetheless, the evidence shows the proposed project would adversely affect larvae and fish eggs, and the Commission finds that it does not include measures to minimize or mitigate these effects, as required under Section 30231.

Wildlife Entanglement

The proposed hydrophone streamers, air-gun array and associated equipment that would be towed behind the survey vessel have the potential to entangle marine wildlife.

Hydrophone Streamers
The proposed towing of four 3.7 mile long cable streamers, an air-gun array and associated equipment behind the project survey vessel presents an entanglement risk to marine wildlife. Sea turtles and marine mammals could become trapped by or wrapped around the air gun array, hydrophone streamers, cables, buoys, or other deployed seismic gear, which could cause injury or fatal drowning. Although PG&E would use marine mammal monitors, the survey is to be carried out on a 24 hour basis during a period in the fall/winter that is often characterized by weather and sea state conditions that would likely reduce the ability of marine mammal observers to effectively sight marine wildlife. The proposed use of passive acoustic monitoring is expected to slightly increase the chance that marine mammals in the area would be identified, but this technology is not effective in identifying the location of the marine mammals relative to the vessel or streamer array and is not capable of detecting sea turtles. In addition, the length of the streamers – 3.7 miles – means that portions of them would extend a great distance from the survey and scout vessels that would support the marine mammal monitors. Therefore, marine wildlife may be able to approach to within close proximity of the project equipment without being observed. Further, the project vessel would respond to observations of marine wildlife within the safety or exclusion zone by reducing speed, not removing the source of potential entanglement from the area.

While a reduction in speed may reduce the potential for entanglement of marine wildlife approaching in some directions, this measure may not be an effective means of responding to animals approaching from all directions. However, given the lengthy process required to deploy and recover the streamers, air gun arrays, and associated equipment, removal of this equipment when marine wildlife is observed near the vessel or streamers is not a feasible option. The most effective means of reducing the potential for entanglement to occur would be for project activities to be carried out during the period of lowest marine mammal and sea turtle density in the project area. As discussed previously, available information regarding marine mammal and sea turtle presence and abundance in the project area suggests that November 1 through December 15 is the period of lowest expected density. If this project were otherwise consistent with Coastal Act requirements, the Commission could condition an approval of the project to require that active air gun operations be limited to the period of November 1 through December 15. This would reduce the likelihood of this wildlife entanglement in project equipment.

Ship Strikes
The proposed project includes the transit of at least one large vessel to the project area and the use of three additional smaller vessels within the project area for an estimated 33 days. The primary project vessel is being held in Astoria, Oregon and is proposed to travel approximately 1000 miles to the project area. In addition, the proposed survey would involve approximately 900 additional miles of survey tracks in Estero Bay for a combined total of nearly 2000 miles of vessel travel by the primary survey vessel, the 235-foot *R/V Marcus Langseth*. Three additional support vessels would also be used during the project, the 110-foot *Nushagak Spirit*, the 100-foot *Michael Uhl*, and the 80-foot *Enterprise*. These vessels would be expected to travel at least 1000 miles during the proposed survey since they would follow the survey vessel. The *Michael Uhl* is a local vessel and would not be required to travel to the project area. PG&E has not provided the current locations and travel distances for the other two support vessels.

Although any oceangoing vessel may be involved in a ship strike with marine wildlife, larger, fast moving vessels are most typically associated with collisions and are the predominant cause of collisions that result in death to marine wildlife. Among the three primary project vessels, the 235-foot *R/V Marcus Langseth* is the largest. This vessel is not known to have been involved in a ship strike since it began operation for the National Science Foundation in 2007, but similar large research vessels operating in California have been known to strike and kill marine wildlife, including large whale species. As a recent example, a similar seismic research vessel, the 176-foot *Pacific Star*, struck and killed an adult blue whale in mid-October of 2009 during low-energy seafloor mapping activities off the coast of northern California.

The EIR notes that:

> *Sea turtles, fish, or marine mammals could be disturbed or struck by the vessels during mobilization to the Project area. As reported in Jensen et al. (2003), of 11 species of whales known to be hit by ships, fin whales (Balaenoptera physalus) are struck most frequently; right whales (Eubalaena glacialis and E. australis), humpback whales (Megaptera novaeangliae), sperm whales (Physeter catodon), and gray whales (Eschrichtius robustus) are also commonly hit. Of 292 large whale ship strikes reviewed in 2004, a total of 48 were known to result in injury and 198 resulted in mortality. No injuries to the whale were reported in only seven ship strike cases. The average vessel speed in 58 of the reported cases that resulted in ship strikes was 18.6 knots (34.4 km per hour), with speed ranges falling into one of three categories: 13 to 15 knots (24 to 38 km per hour), 16 to 18 knots (29.6 to 33.3 km per hour), and 22 to 24 knots (40.7 to 44.4 km per hour) (Jensen et al. 2003).*
>
> …
>
> *As noted above, the Project-related vessels would typically travel at speeds of approximately 10 to 12 knots (18.5 to 22 km per hour), which is lower than the range of speeds associated with marine mammal collisions (greater than 13 knots [24 km per hour] [Jensen et al. 2003]) during transit to the site. However, lethal collisions, even with slow-moving survey boats, have recently occurred in the region and the risk of collisions may increase at night when surface feeding rates increase.*
>
> *During mobilization and demobilization, the survey vessel's activity would be equivalent to that of similar vessels in the area, such as fishing boats and commercial vessels.*

Regarding the potential for vessel collisions to occur with marine wildlife during active operations, the EIR notes that some whale species in central California, including blue whales, have been shown to be particularly susceptible to ship strikes and that the risk of collisions may increase at night when surface feeding behavior in these whales becomes more common.

The potential occurrence of ship strikes would be reduced primarily by the low proposed speeds of the project vessels during survey operations, the use of marine mammal observers on the project vessels, and the adherence of project vessels to appropriate safety protocols. In its approval, the CSLC is requiring PG&E to prepare and implement a Marine Wildlife Contingency Plan. On October 17, 2012, PG&E submitted to the Commission a draft plan that includes commitments to: (1) maintain at least three dedicated protected species observers onboard of all

of the project support vessels during transit to the project area; (2) carry out these transits during daylight hours; (3) have the protected species observers positioned on the vessel with a clear view of the area in the direction of and adjacent to the course of travel to look for marine wildlife; (4) maintain a minimum distance of 1,640 feet from any observed marine mammals or sea turtles; (5) slow the vessel or change course as necessary in order to maintain this distance and avoid contact; (6) initiate a series of whale specific safety measures; and (7) immediately record key information regarding any collisions and report them to the NMFS Stranding Coordinator, DFG, and CSLC staff.

While these measures would reduce the potential occurrence of collisions between project support vessels and marine wildlife, the plan does not specify that such measures would also apply to the primary research vessel, the *R/V Langseth*. In order to ensure that the risk of collision is reduced, the Commission could require that PG&E's Marine Wildlife Contingency Plan include standard measures for this vessel as well, such as the use of marine mammal observers during daylight hours, and reduced vessel speeds (less than ten knots) near areas in which whales have been sighted. With the addition of such a requirement, the Commission could find that PG&E would be minimizing the potential risk the project would pose to marine wildlife from ship strikes.

Marine Protected Areas

The California Marine Life Protection Act Initiative process in the central coast study region was carried out from 2004 to 2007 with collaboration, input, and expertise from a wide variety of stakeholders, scientists, and experts. The goal of this process was to redesign California's system of marine protected areas (MPAs) to function as a network in order to: increase coherence and effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage, as well as to improve recreational, educational and study opportunities provided by marine ecosystems subject to minimal human disturbance. Ultimately, this process resulted in the identification of specific areas within state coastal waters which supported unique assemblages of diverse species and habitats which, if provided with additional protection from injury, disturbance, and loss, would be expected to: 1) protect the natural diversity and abundance of marine life, and the structure, function and integrity of marine ecosystems; 2) help sustain, conserve and protect marine life populations, including those of economic value, and rebuild those that are depleted; 3) improve recreational, educational and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, to manage these uses in a manner consistent with protecting biodiversity; 4) protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic values; 5) ensure California's MPAs have clearly defined objectives, effective management measures and adequate enforcement and are based on sound scientific guidelines; and 6) ensure the State's MPAs are designed and managed, to the extent possible, as a network.

On April 13, 2007, the Fish and Game Commission voted unanimously to adopt 29 marine protected areas (MPAs) covering many of those areas along the central coast that were identified as particularly important through the Marine Life Protection Act Initiative process due to the habitats and species of special biological significance they support. The proposed project would include high-energy seismic survey activities in close proximity to two of these 29 MPAs, the

Point Buchon State Marine Reserve and Point Buchon Marine Conservation Area. In addition, the project would also result in elevated sound levels within the White Rock State Marine Conservation Area. The discharge of elevated sound levels into these MPAs has the potential to result in the disturbance, injury, and loss of marine life within the MPAs.

Section 30230 of the Coastal Act requires, in part, that special protection be given to areas and species of special biological significance. Given the collaborative stakeholder process and detailed scientific evaluation that informed the designation of the Point Buchon State Marine Reserve, Point Buchon Marine Conservation Area, and White Rock State Marine Conservation Area all three of these MPAs are considered to support areas and species of special biological significance. The Commission must therefore find that the proposed project provides all three areas with special protection. Given all of the project's expected impacts, described above, the proposed use of high-energy air guns in the nearshore and offshore waters adjacent to the Point Buchon MPAs clearly does not provide these areas with special protection. The Commission therefore finds that the proposed project is inconsistent with Section 30230 of the Coastal Act.

Conclusion
The Commission finds that, for the reasons discussed above, the proposed project would result in adverse impacts to marine resources and the biological productivity of coastal waters. These adverse effects include behavioral harassment and potentially injurious physiological effect on large numbers of marine mammals; the loss of fish and invertebrate eggs and larvae; the injury, disturbance, and loss of adult fish and invertebrates; and damage to marine protected areas. While the use of marine mammal monitors, the relatively low speed of the research and support vessels and other mitigation measures may reduce some of these impacts, such measures are limited in their effectiveness under expected project conditions, so these impacts are likely to occur to some degree regardless of the inclusion of impact reduction measures.

In addition, the proposed project has the potential to result in additional adverse impacts to marine biological resources through entanglement of marine wildlife in project equipment and ship strikes. These latter impacts, however, could be addressed through imposition of additional mitigation measures.

For these reasons, the Commission finds the proposed project inconsistent with Sections 30230 and 30231 of the Coastal Act. However, this project qualifies for special consideration under the Coastal Act's coastal-dependent industrial "override" policy (Coastal Act Section 30260), which is discussed in the Coastal Dependent Industrial Override Section of this report. See Section M of this report.

H. COMMERCIAL AND RECREATIONAL FISHING

Section 30234.5 of the Coastal Act states:

> *The economic, commercial, and recreational importance of fishing activities shall be recognized and protected.*

Commercial Fishing
Commercial fishing is an important component of the regional economy in San Luis Obispo County. The County's LCP, which the Commission may use for guidance, identifies commercial fishing as a top priority coastal use.[14] The area's commercial fishing activities focus on several species, including crab, various rockfish, and pelagic species such as salmon and albacore. The commercial fishery employs a range of gear types, including trawl, gill net, trap, diving, round-haul nets, and hook-and-line. Most of the area's commercial fishing is conducted out of Morro Bay Harbor or Port San Luis Harbor. Although the proposed survey is relatively short-term, it would cause adverse fishing-related effects in areas important to the local commercial fishing interests and is likely to result in some degree of longer-term effects on fishing.

Commercial Fishing Data
Commission staff used several data sources, including "fish catch blocks", commercial landings, and seasonal records to assess the importance of the area's commercial activities and possible survey-related effects on those activities, as described below:

- **Fish Catch Blocks:** The California Department of Fish and Game (DFG) collects commercial catch data using "fish catch blocks," which are mapped and numbered areas covering much of the state's offshore waters. Commercial buyers and recreational fishing vessels report catches within these blocks, each of which covers about 100 square nautical miles of marine waters. Although there are inaccuracies inherent in this reporting system (e.g., as explained in *Report on Marine Protection Act Initiatives* in Ecotrust 2006), it is has provided an established means for the past several decades of reporting and characterizing fish catch in California's offshore waters.[15]

  The footprint of the proposed survey, and the areas in which the survey's anticipated sound propagation levels are expected to affect marine life (as described in Section G of these Findings), are within portions of four blocks, including Fish Catch Blocks 607, 608, 615, and 616. Mobilization and demobilization of project equipment may affect other nearby areas. These catch blocks represent an important component of the area's commercial fisheries, as shown in the table below. It lists the total annual catch from the catch blocks, by weight and dollar value, for the most recent 10 years available – 2001 to 2010 – as well as the main species caught within those blocks, in order of average weight (CSLC 2012).

Fish Catch Block	Predominant Species Caught	Average Weight (lbs.)	Average Value (current $$)

[14] The San Luis Obispo County Local Coastal Program includes the following policy in its Chapter 5 – Commercial Fishing and Recreational Boating:

> ***Policy 1:*** *Protection of Commercial Fishing and Recreational Boating Opportunities – Commercial fishing and recreational boating shall be protected and where feasible upgraded. Commercial fishing needs shall be assigned first priority. Recreational boating facilities shall be designed and located to not interfere with the needs of the commercial fishing industry. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD.]*

[15] Additional information about the Fish Catch Block System and data collection can be found at the DFG website: http://www.dfg.ca.gov/marine/landings10. asp

607	Pacific sardine, market squid, pink shrimp	59,278	$110, 495
608	Market squid, Dover sole, longspine thornyhead	56,297	$59,689
615	Hagfish, market squid, sablefish	159,871	$371,799
616	Sablefish, chinook salmon, hagfish	20,946	$31,486
Total:		***296,392***	***$462,974***

- **Commercial Landings Data:** In addition to the information available from the Fish Catch Block System, commercial fishing data for the project area is available from landings reported at Morro Bay and Port San Luis. While "catch" refers to the amount and value of fish caught, and is reported in terms of weight and dollars, respectively, "landings" refer to the amount and value of fish brought in to the ports, with landings values representing the amount of money paid to the fishermen. Similar to the catch values above, these data do not provide an exact description of commercial fishing's importance in the area's economy – for example, they include fish landed by commercial fishing interests from outside the area, and do not include fish taken to other harbors by local commercial fishing interests – however, they provide a general measure of economic value. The table below, which is derived from the project EIR, provides the annual commercial landings for Port San Luis and Morro Bay for all gear types and species from 2000 to 2009. Although the annual landings are highly variable, they represent an average yearly value of about $1.19 million at Port San Luis and about $2.6 million at Morro Bay.

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Port San Luis										
Weight (in millions lbs.)	1.13	1.26	3.14	2.89	1.63	0.18	0.29	0.24	0.25	0.32
Value (in millions $$)	1.14	1.32	1.86	1.69	1.26	0.71	1.02	0.96	0.89	1.09
Morro Bay										
Weight (in millions lbs.)	2.47	2.62	1.65	2.14	3.13	1.68	0.86	0.66	1.03	2.60
Value (in millions $$)	4.41	3.44	2.49	1.70	2.18	2.19	1.90	1.68	1.84	3.72

Note: Dollar values are in current dollars (not adjusted for inflation).
Source: CDFG 2011b, CDFG 2011e, BOEMRE 2011.

- **Seasonality of Fishing in Project Area:** The area's commercial fishing activity varies seasonally, with the peak fishing season generally occurring in the summer and lower or moderate levels during November and December. Data provided in the EIR (see EIR Table 4.13-5) show that catch totals during the November-December period for the past ten years represent between 10-15% of the average year's catch (i.e., about 140,000 lbs. of an annual total of about 1.07 million lbs.), with the average year's landings representing a similar proportion (i.e., about 370,000 lbs. of an annual total of about 3.025 million lbs.).

Recreational Fishing
Recreational fishing is a similarly important part of the local and regional economy. Although the abundance of fish caught varies year-to-year, the proposed November-December survey period would generally coincide with parts of the peak seasons for several species that support recreational fishing activities, including charter boats and other fishing-related businesses in the area, as well as an active community of recreational divers and fishers. For example, the albacore season changes each year, but generally occurs sometime between August and November. The lingcod and rockfish seasons generally run from May through December. The project EIR, although based on a larger project than the currently proposed survey, nonetheless concluded that preclusion of recreational fishing during a peak season would cause a significant adverse effect. The EIR states:

> *The Project would not restrict recreational fishing for the entirety of a peak season for all targeted species, and recreational fishing could still take place outside of the active Project area. However, for the purposes of this analysis, preclusion does occur during a peak season and is therefore significant.*

Numeric estimates of the proposed survey's effects on recreational fishing in the survey area are not available but, as stated in the EIR, the disruption of this activity due to the proposed project would result in significant and unavoidable impacts.

Effects on Fishing Activities
While the survey would result in some adverse impacts to commercial and recreational fishing, the Commission, for several reasons, cannot determine the exact effects of the proposed survey on these activities. For example, because commercial fishing data are tabulated by entire catch blocks and by full months, they do not allow for calculations to determine the effects of a survey occurring within only portions of those blocks or during just part of a month. Additionally, the survey would occur within only part of the offshore fishing grounds used by the regional fishing community, so its exact effects on the overall catch or landing totals are unclear. Still, we can identify two main types of the survey's adverse effects on commercial and recreational fishing: first, effects on the fishing activities themselves, such as preclusion of fishing vessels and fishing effort from areas within the survey footprint during active operations and the potential for lost fishing gear; and second, effects on the area's fish and invertebrates that would reduce catch opportunities. These are each described in more detail below.

The proposed project would entail the use of up to five vessels within the project area for up to about 33 days between mid-November and December 31. PG&E expects active survey operations to occur for about 10 of those days, though survey activities could occur throughout the expected 33 days due to maintenance delays, disruption due to unfavorable ocean conditions, the observed presence of marine mammals within the survey area, or other factors.

Due to the risk of vessel collisions, entanglement with project equipment, and other considerations, much of the project footprint would be restricted or closed to non-project vessels during these periods. As noted in the EIR, PG&E would request that the U.S. Coast Guard (USCG) issue a Notice to Mariners outlining restrictions to other vessels within and near the survey area. The EIR states that for purposes of safety and to ensure the integrity of the data

collection process, PG&E has proposed that vessels maintain the following distances from the *R/V Langseth*:

- 3.2 km (2 mi.) ahead,
- 8.8 km (5.5 mi.) astern; and,
- 4.8 km (3 mi.) to the side when a ship or other vessel is passing the survey vessel.

These proposed distances would create a continually moving 35-square mile exclusion zone around the survey vessel that would directly preclude commercial and recreational fishing activities. This preclusion area would move within the approximately 150-square miles of Box 4 during the proposed six-week survey period from mid-November through December, 2012. This closure would coincide with parts of the peak seasons for several area fisheries. As shown in the table below (based on data from the project EIR), the survey is proposed to occur during seasons for several important commercial fisheries and result in reduced fishing opportunities for several of those fisheries.

Species	**Seasonal Factors for 2012**	**Impact of Proposed Six-Week Survey Period**
Market squid	Generally year-round; however, the season closed in November 2011.	If the fishery remains open throughout 2012, the project may restrict the fishery for up to six weeks
Pacific sardine	25% of annual harvest allocation opens on Sept 15th, plus any remaining allocation from earlier in the year.	Would reduce season by an unknown proportion.
Hagfish	No seasonal restrictions.	Would reduce season by about 12.5% (i.e., 1 ½ months out of 12).
Sablefish	Longline, trap, and trawl by-catch allowed year-round.	Would reduce season by about 12.5% (i.e., 1 ½ months out of 12).
Dungeness crab	Season opens November 15th	Would restrict first six weeks of season.
Spot prawn	Opens August 1st	Would restrict approximately 1 ½ months of season

Although some fishing activities may be able to respond to preclusion by relocating to areas outside the project footprint, this could result in increased fuel costs, increased competition, and the need to fish in areas with lower productivity. However, for those fisheries in which licenses apply to specific areas, the ability to relocate may be limited or infeasible. Additionally, while fisheries may be able to "fish around the survey" by targeting those portions of the project area that are not being actively used for project operations, this, too, may be limited or infeasible in some cases. For example, fisheries using set gear, such as crab pots, would not be likely to employ this strategy since it may not be possible or practical to plan the placement of gear around the anticipated survey schedule and location. Those fishing vessels that do place gear in or near the survey area risk losses due to entanglement or collision. Overall, therefore, the

adverse effects resulting from preclusion of fishing within the survey area are not likely to be significantly reduced or avoided by relocating those fishing efforts to areas outside the project area or by "fishing around" the active survey locations.

Effects on Area Fish and Invertebrates
The survey is likely to result in both short- and long-term effects on nearby species, including many marine life populations important to commercial and recreational fishing. Each category is described in more detail below.

- **Short-term Effects:** The most likely short-term adverse effects to the fishing community are the reductions in catch that could result from the species' "startle" and "alarm" behavioral responses caused by the sounds generated by the survey's air guns. A number of studies have attempted to describe and quantify this effect, including several summarized in the project EIR (see EIR Table 4.13-10 – Summary of Literature Showing Observable Effects of Seismic Surveys on Fish Catch). Many of these studies attempted to determine a "no observable effect" decibel level for various species, though most of the cited studies were conducted in areas other than the project area and on species not present in the survey area. Results of these studies show a range of responses by different species at different decibel levels – e.g., no observable effect on hake at less than 149 decibels, rockfish catch reductions of about 50% at 186-191 decibels, ear damage on pink snapper at 180 decibels, etc. Additionally, the study designs were generally limited to identifying specific effects of a narrow decibel range at a particular distance. It is therefore difficult to determine the full range of likely effects the proposed survey's inwater sounds would have on area species, the distance at which those effects would occur, and the time period during which those effects might last. The study results suggest, however, that adverse fishing-related effects, such as multiple days of reduced catch levels, can occur with sounds in the range of at or above about 160 decibels. This is well below the expected 250 decibel maximum sound levels from the air guns and would cover a distance of up to about six miles from the air gun array.

  Another associated short-term adverse effect is a decrease in "catch per unit effort" or CPUE. The effect described above – i.e., the reduced likelihood of catching species that show "alarm" or "startle" responses to the air gun sounds – can lead to the need for a greater level of effort required to catch a given number of fish. Decreased CPUE can show up in a number of ways that affect the economic vitality of the local fishing community – increased fuel consumption needed to cover a larger fishing area, inefficiencies associated with fishing in a less familiar area, cumulative effects of having more fishing boats share a smaller overall fishing area, etc. The effects of decreased CPUE are similar in at least one way to those described above regarding overall reductions in catch – i.e., they are difficult to measure precisely – but they differ in that the effects of CPUE would be felt over a larger area and by more of the fishing community than those directly affected by the catch reductions.

  In sum, these short-term impacts, while difficult to measure, would likely result in reductions in catch throughout the survey area as well as increased CPUE that would extend beyond the survey area. In both cases, the effects are likely to last for up to several weeks, and are likely to adversely affect the economic vitality of the local fishing community for at least that period of time. Although the project EIR evaluated these issues for a larger version of the

proposed project, it noted that the combination of both these effects within the same area and timeframe resulted in a significant adverse impact.

- **Long-term Effects:** The most likely long-term effects to area fishing interests are those associated with mortality and injury of adult and larval fish and invertebrates, as well as eggs of those organisms, as previously discussed in Section IIG of these Findings. However, because of the many environmental and population variables that go into determining survivorship, population dynamics, community structure, and other similar ecosystem characteristics, it is not possible to determine with precision the extent of these effects.

  Losses of adult fish are likely to be relatively low, since they would need to be relatively close to the air guns (i.e., within several dozen feet) to experience death or injury. However, a loss of adults in some species could result in reduced catch rates in the area for as many as several seasons – for example, because rockfish generally grow relatively slowly to adulthood, losses of adult rockfish could require some time for replacement populations to develop. Regarding larvae and eggs, the losses are expected to be in the range of about 5 million, as discussed in Section G above. The EIR notes that several factors are likely to reduce the potential effects resulting from these losses – for example, this total represents a relatively small proportion of larvae within the survey area and within the region, and the survey would occur outside the area's peak larval concentrations in the spring and summer. PG&E expects this level of loss to have an insignificant effect on the area's adult fish population, though, as noted above, there are few studies to support this predicted level of mortality or to identify other adverse sublethal effects that may affect eventual adult populations. In general, however, losses of these organisms are likely to reduce to some degree the numbers of certain species that would otherwise be available to the fishing community.

- **Cumulative Impacts:** As noted in the 2008 Morro Bay and Port San Luis Commercial Fisheries Business Plan, the area's commercial fishing is still an important part of the local and regional economy, but has been in decline over the past several decades. This Plan describes the decline as "precipitous" due largely to declines in fish stocks, the cyclical nature of many stocks, market problems, and reduced access to certain stocks due to fisheries regulations. As a result, any unmitigated impacts from the survey would be in addition to the existing set of adverse effects already contributing to this ongoing decline.

In sum, although the exact type and extent of adverse effects cannot be calculated, the proposed project will clearly cause some degree of disruption and possible losses to the area's commercial and recreational fishing interests. Mitigation measures needed to address these effects are described below.

Mitigation Measures

To address the effects of preclusion, the California State Lands Commission required PG&E to develop a Communications Plan for managing communication and outreach with the fishing community and to ensure that fishermen have adequate information about the project to limit the need to avoid the project area to the minimum necessary. On October 5, 2012, PG&E submitted to the Commission a draft Communications Plan; however, the draft Plan does not yet include

sufficient measures to provide adequate, updated, and complete noticing to the public in the project area regarding the location, timing, duration, and sound levels associated with the proposed project. For example, it does not: (1) propose a method to provide updated sound propagation information if the sound source verification process reveals that the modeled assumptions were inaccurate; (2) provide for updating PG&E's database of interested parties based on the participants in the review and comment opportunities provided by the Coastal Commission, California Department of Fish and Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service, or National Science Foundation; and (3) include common means of communication such as email or social media that may be more likely to provide timely information to a wider audience. A modified Communications Plan that includes the above-identified elements, if fully implemented, would reduce expected impacts to the fishing community, though fishing within most of the survey area would still be effectively eliminated during all or much of the survey period. In addition, and as described below, PG&E has not yet reached agreement with the fishing community regarding adequate mitigation for lost fishing opportunities and the additional costs to the fishing community that may result from the survey. Without an adequate Communications Plan, the Commission is unable to determine that PG&E's proposed survey will be adequately protective of commercial fishing activities.

Regarding impacts such as lost catch opportunities, possible lost fishing gear, and others, Commission staff requested that PG&E develop and submit a Fishing Mitigation Plan outlining the steps PG&E would take to address adverse impacts to commercial and recreational fishing operations, including the reduction or displacement of fishing activities or catch during and after survey operations. PG&E had initially proposed a base compensation amount of $1.2 million dollars to be disbursed to the fishing community and noted the existence of its existing claims process for damages related to PG&E operations (e.g., damages due to electrical outages, powerline damages, etc.). PG&E provided a September 5, 2012 letter outlining the key steps of its proposed fishing mitigation plan, which included the following:

> *Under PG&E's existing claims process, an individual or business would file a claim form with supporting documentation to the company. Supporting documentation would include official fish tickets submitted to the California Department of Fish and Game (CDFG) and other financial data to demonstrate losses. After reviewing the documentation, PG&E's Claims Department would issue payment for those demonstrated losses. The length of this process varies depending on the magnitude of the loss, where smaller claims with appropriate documentation being processed in about 30 days. Larger claims are subject to additional internal controls and may take longer to process.*
> *There are several ways to submit a claim to the company. A claimant can:*
> *(a) File claims online at:*
> *http://www.pge.com/mybusiness/customerservice/contact/claims/*
> *Supporting documents are sent by email to claimsdocs@pge.com*
> *(b) File claim by email by sending completed claim form and documentation to lawclaims@pge.com.*
> *(c) File by mail at PG&E Claims, 1850 Gateway Blvd, 6th Floor, Concord, CA 94520*
>
> *PG&E's lead representative for any claims associated with the CCSIP is:*
> *Carolyn Hanson*

Pacific Gas and Electric Company
160 Cow Meadow Place
Templeton, CA 94365
(805) 434-4404

For any disputed claims, an eligible mediator in the San Luis Obispo County area would be hired to resolve the claim. Mediation does not require legal representation and the mediator acts to understand the perspectives of both sides to help reach an agreement. The mediator would be jointly selected by representatives from PG&E, the Morro Bay Commercial Fishermen's Organization (MBCFO), the Port San Luis Fishing Association (PSLFA) and ocean-based businesses located in San Luis Obispo County.

Commission staff noted that this proposal lacked several key details. It no longer included the earlier proposed $1.2 million baseline compensation fund, it did not specify how payments would be made, and it was vague about the information needed to process a claim and the criteria that would be used to evaluate the claims. The proposal also suggested the need for additional mediation with the fishing community to further modify the plan and to reach an agreement on its implementation. Commission staff believed this proposal lacked sufficient information and certainty to ensure it would protect commercial and recreational fishing activities as required by Coastal Act Section 30234.5.

Commission staff then requested PG&E provide additional detailed information, including a proposed compensation amount, and develop a claims process specifically applicable to possible damages resulting from the proposed survey. Staff recommended that PG&E develop a process similar to the Joint Oil/Fisheries Liaison Office (JOFLO), which has been used successfully since 1983 to manage claims from fishing interests for damages associated with offshore oil and gas production in California. The JOFLO process includes several key characteristics that result in a successful mitigation strategy to address damages to fishing interests. JOFLO provides an independent liaison office to review claims, to assist fishing interests in meeting filing requirements, and to provide mediation when necessary to settle claims. It also includes guidelines for claims and a standardized claims process. Further, claims managed through JOFLO benefit from contingency funds administered by the National Marine Fisheries Service, the Bureau of Ocean Energy Management (BOEM), and the County of Santa Barbara that are adequate to address valid damage claims from the fishing community. Although JOFLO was established as a means to provide long-term mitigation, Commission staff believes it serves as an appropriate model on which to base mitigation needed for PG&E's relatively short-term survey.

On October 5, 2012, PG&E submitted additional information about its proposed plan, which included the following:

- PG&E noted that its proposed base compensation amount was still being negotiated with local fishing interests. PG&E has proposed providing an initial lump sum that would be disbursed among affected commercial fishing interests in a manner still to be determined.
- PG&E again proposed to use its existing claims process to address claims beyond the initial base compensation amount, and again proposed the same mediation process as described in its September 5, 2012 proposal to settle any disputed claims.

- PG&E proposed to retain JOFLO to assist parties in filing claims and to serve as an ombudsman, though it did not propose to incorporate other aspects of the JOFLO process into its claims process.

This most recent proposal, however, still lacks the information and certainty needed to ensure effective mitigation for potential impacts to the fishing community. For example, PG&E's proposal to partially retain JOFLO is apparently not an available option, as JOFLO is available to its members only (though PG&E could obtain JOFLO's services by becoming a member). The Commission believes that a more robust mitigation plan based on the JOFLO model would likely provide the necessary level of mitigation; however, absent some basic information about the level of compensation PG&E would provide, the process and basis for making damage claims and resolving those claims, and concurrence from the affected fishing interests about this approach, the Commission finds that there is insufficient information to find the currently proposed compensation plan is adequate to protect fisheries or is consistent with Coastal Act Section 30234.5.

Conclusion
The project would result in significant short-term impacts to both commercial and recreational fishing from preclusion of fishing efforts in the project area during the proposed survey and from behavioral reactions of targeted fish and invertebrate species that would reduce catch per unit effort both during and after the project. In addition, the anticipated injury and mortality to fish and fish larvae that would result from the proposed project activities has the potential to cause both short and long term adverse impacts to commercial and recreational fishing. For these reasons, the Commission finds the project as currently proposed to be inconsistent with the commercial and recreational fishing policy at Coastal Act, Section 30234.5. As noted above, the Commission believes a more complete Communications Plan and a more robust, comprehensive and detailed fishing mitigation plan based on the JOFLO model could be sufficient to ensure protection of commercial and recreational fishing activities. However, the Commission does not currently have a plan that is detailed enough for it to assess whether mitigation would be adequate to meet Coastal Act Section 30234.5. If the proposed project were otherwise consistent with other Coastal Act policies, the Commission could ensure consistency with Section 30234.5 by requiring: (1) a more comprehensive Communications Plan identifying how PG&E would provide updated sound propagation information to the affected fishing community, how PG&E would update its database of parties interested in reviewing and commenting on the proposed project, and including measures for providing timely information updates via social media; and (2) a more comprehensive Mitigation Plan based on the JOFLO model that specifies a baseline compensation amount to address expected impacts to the fishing community, includes clear guidance on the criteria and process used to submit and determine valid claims, and to resolve any claim-related disputes.

I. ACCESS AND RECREATION

Section 30210 of the Coastal Act states:

> *In carrying out the requirement of Section 4 of Article X of the California Constitution, maximum access, which shall be conspicuously posted, and recreational opportunities*

shall be provided for all the people consistent with public safety needs and the need to protect public rights, rights of private property owners, and natural resource areas from overuse.

Section 30211 of the Coastal Act states:

Development shall not interfere with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation.

Section 30220 of the Coastal Act states:

Coastal areas suited for water-oriented recreational activities that cannot readily be provided at inland water areas shall be protected for such uses.

Water-oriented or ocean-based recreation activities in and around the project area include whale watching, fishing (discussed above in Section H of this report), diving, surfing, swimming, sailing, boating, and other similar water sports. The proposed project has the potential to adversely affect coastal access and recreation in several ways, including (1) by restricting water-oriented recreational activities from occurring in areas near active survey operations due to human safety concerns; (2) by establishing a vessel closure area around the survey vessel during active survey operations; and (3) through the placement of structures in beach areas.

Restriction of Water-Oriented Recreation
Underwater sound levels in several nearshore areas may result in a temporary reduction in water-oriented recreation within the project area. Regarding the effect of underwater noise on human health, the EIR notes that studies have shown that high levels of underwater noise can cause dizziness, hearing damage, or other sensitive organ damage to divers and swimmers, as well as indirect injury due to startle responses. The table below (derived from information in the EIR) shows suggested noise thresholds for recreational divers.

Source	Frequency Range (Hz)	Maximum Value (dB re: 1 µPa)
NATO Undersea Research Centre	600 to 2500	154
Diving Medical Advisory Committee	Unspecified; believed to be 1,500	201
Parvin	500 to 2500	155

Based on this information, the EIR concluded that noise levels in excess of 154 dB re 1 µPa could be considered potentially harmful to recreational divers and swimmers in the project area. Additional studies carried out in 1997 and 1999 (Stevens et al. 1997 and Cudahy et al. 1999) to assist the U.S. Navy in establishing safety thresholds for diver exposure to low frequency active sonar resulted in the Navy setting standard safety protocols that call for the avoidance of all low-frequency active sonar levels above 145 dB in known commercial or recreational dive sites. The studies carried out for the Navy used frequency ranges (100 to 500 Hz) that were substantially lower than those in the table included above and more closely match the dominant frequencies that would be generated by the proposed seismic surveys (0 to 188 Hz). Although no research

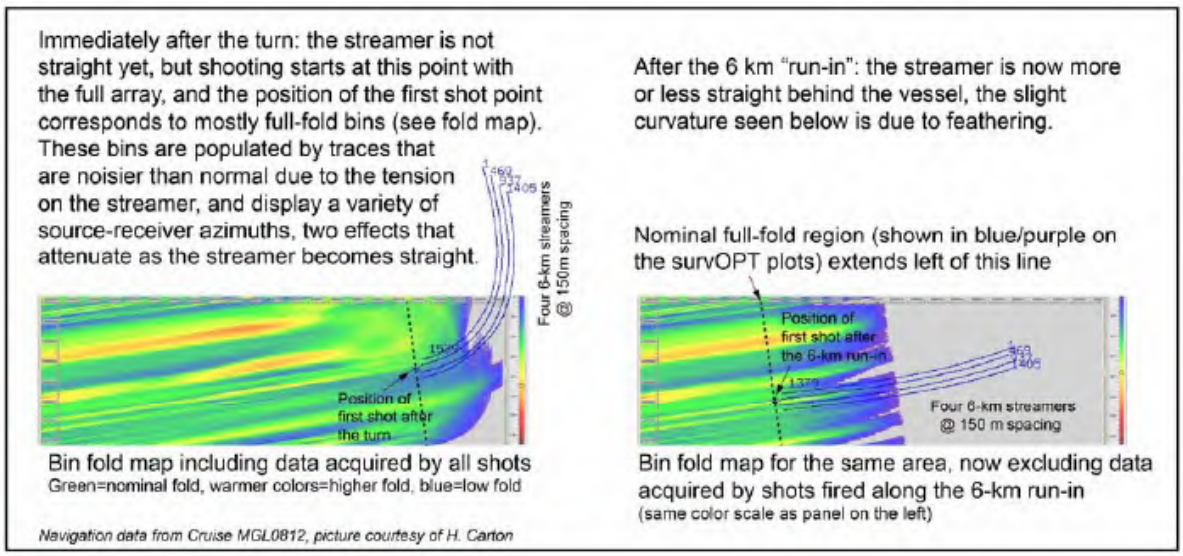
has been carried out on human exposure to seismic air gun generated sound, the research carried out for the Navy using low frequency active sonar may be the closest available approximation.

While divers, swimmers, surfers, and other persons would be unlikely to approach within close range of the active survey vessel (primarily because it would remain at least one mile from shore and would be flanked by support vessels enforcing a vessel and diver exclusion zone), the proposed sound levels associated with the survey would result in elevated received sound levels a substantial distance from the vessel itself, including in nearshore areas frequented by surfers, swimmers, spearfishers, and divers. Some of these exposed areas, including sites in Montana de Oro State Beach, near Morro Rock, and in Cayucos, are among the most popular and consistently used ocean recreation areas in San Luis Obispo County, primarily due to their consistent draw for surfers. These sites are especially popular during the late fall and winter months when swell size and frequency provides consistent opportunities for surfing.

At the request of Commission staff, PG&E submitted a map of the received sound levels in nearshore waters that would be expected from the survey activities, based on sound propagation models. This map is included as Exhibit 7 and suggests that nearshore areas from Montana de Oro State Park to Cambria would be expected to experience received sound levels in excess of 160 dB re 1 μPa.

Given the information provided in Exhibit 7 and the proximity of proposed survey activities to shore in several locations, sound exposure levels for nearshore recreational areas in Montana de Oro, Morro Bay, and between Cambria and Cayucos are anticipated to be substantially higher than the levels found to be safe for human exposure. Individuals engaged in water-oriented recreational activities in these areas during active survey operations may therefore be at an increased risk of injury. While PG&E has not proposed to close any beaches, recreationists concerned about their safety may avoid surfing, diving, and swimming during the survey (perhaps a total of 17 days (the estimated amount of time required for preliminary sound verification work and the survey of Box 4)).

As noted above, PG&E submitted the figure included as Exhibit 7 to demonstrate the anticipated sound propagation distances and received sound levels in beach areas throughout the project area. However, this figure does not accurately depict the anticipated sound levels that would be received in beach and coastal areas within the project area because the vessel locations from which the “full air gun array” sound propagation distances are calculated are further offshore than the survey vessel would be when it begins firing of the full air gun array. As discussed in a letter provided to the Independent Peer Review Panel on October 19, 2012, the full air gun array would begin firing as soon as the vessel completes each turn:



This would substantially increase the received sound levels in nearshore waters along the coast from Montana de Oro State Beach to Cambria beyond those depicted in the figure provided in Exhibit 7. Received sound levels would be expected to exceed 160 dB throughout this area during the proposed survey activities, with the highest levels received each time the survey vessel approaches or completes one of its shoreside turns. Additionally, the sound propagation distances depicted in the figure above are based on the modeled behavior of underwater sound waves in the project area. Until five day sound source verification process is completed at the initiation of active survey operations, the actual sound levels and distances will not be known with complete certainty. As such, the received sound levels in nearshore areas may further exceed or fall short of modeled expectations.

The CSLC is requiring PG&E to develop a Communication Plan that would include providing beach and ocean users with accurate and updated notifications of the dates of air gun use. On October 5, 2012, PG&E submitted to the Commission a draft Communications Plan. In its current form, the Communications Plan does not provide sufficient efforts or measures to provide adequate, updated, and complete noticing to the public in the project area regarding the location, timing, duration, and sound levels associated with the proposed project. Specifically, it does not: (1) include posting of signage or notices at beaches, coastal access sites, or beach parking areas; (2) propose a means of providing updated sound propagation information if the sound source verification process reveals that the modeled assumptions were inaccurate; (3) provide a means of updating PG&E's database of interested parties based on the participants in the review and comment opportunities provided by the Coastal Commission, California Department of Fish and Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service, or National Science Foundation; and (4) include common means of communication such as email or social media that may be more likely to provide timely information to a wider audience. A modified Communications Plan that includes the above-identified elements, if fully implemented, would reduce expected ocean recreational impacts, but recreational use in these popular coastal areas would still be effectively eliminated during the estimated 17 days of air gun use. Thus, without mitigation to compensate for lost recreational opportunities, the project is not consistent with the Coastal Act's standard to protect water-oriented recreational activities. Since

PG&E has not offered mitigation for the loss of surfing days and other lost ocean recreational opportunities due to survey operations (e.g., local public access and recreational improvements or in lieu mitigation payment), the Commission cannot at this time find that the project will be carried out consistent with the Coastal Act's public access and recreation protection policies.

Preclusion of Vessel Activity
In coordination with the U.S. Coast Guard, PG&E proposes to close to non-project vessels all waters within a specified proximity of active survey operations. This moving closure would follow the survey vessel and apply to all non-project vessels, including recreational boating, sailing, and whale watching activities. The closure would be in place both as a safety measure (to prevent collisions and entanglement with project equipment) and to preserve the integrity of survey operations. The closure would include all waters two miles ahead, five and a half miles behind, and three miles to each side of the survey vessel (for a total area of about 35 square miles roughly centered on the survey vessel).

The location of this 35 square mile closure area would be continually adjusted as the survey vessel moves, requiring recreational boats in offshore areas to temporarily change course. PG&E's Communications Plan is also a tool to disseminate to recreational boaters accurate and current project information and survey dates and therefore increase the ability of the recreational boating community to respond and adapt to preclusion areas. The plan can serve to provide adequate noticing, but implementation of the project would nevertheless result in recreational boating preclusion during survey operations.

Placement of Structures in Beach Areas
Although PG&E proposes to place temporarily approximately 90 passive seismic monitoring devices (geophones) on Morro Strand beach – the beach area stretching from Montana de Oro State Park to the inlet of Morro Bay -- their presence will not interfere with the public's access to and use of the beach. The proposed geophone devices are approximately five inches in diameter, would be installed by hand widely spaced throughout a several mile long stretch of Morro Strand beach, and would be buried in place for the duration of the survey only. As such, the Commission finds that the placement onshore of temporary geophones would not adversely affect coastal access or recreation.

Conclusion
As described above, the proposed project would result in the temporary closure of the offshore project area to recreational boating and diving activities. Expected high nearshore underwater sound levels may also discourage surfers, swimmers and divers from entering the ocean during survey operations and therefore result in a "de facto" closure. An appropriately thorough communications and noticing strategy by PG&E would serve to minimize some of these impacts but would not mitigate or compensate fully for lost ocean recreation use. If the proposed project were otherwise consistent with the Coastal Act, the Commission could require (1) a more comprehensive Communication Plan to minimize the project's impacts on public access and recreation, and (2) mitigation in the form of public access and recreation improvements or an in lieu mitigation payment.

J. CULTURAL RESOURCES

Section 30244 of the Coastal Act states:

> *Where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required.*

The proposed project involves very limited ground disturbing activities onshore – the temporary placement by hand of 90 small geophones on Morro Strand beach for the duration of the proposed project. The State Historic Preservation Officer (SHPO) has not identified any archeological or paleontological resources in the areas in which PG&E would temporarily place geophones.

However, the Northern Chumash Tribal Council (NCTC) has also expressed a variety of concerns to the Commission regarding potential adverse impacts to cultural resources. In a letter dated August 29, 2012, Mr. Fred Collins of the NCTC states:

> *As I have mentioned before in our conversations NCTC is extremely concerned about the abuse of the Chumash Nation Creation Story, most people all over the world know about the "Rainbow Bridge" story, the Dolphins are our Ancestors. The potential killing of our Ancestors is Traumatic Trauma to the members of NCTC and the Chumash community. NCTC is of the opinion that this is one of many violations of our Freedom of Religion Act rights, and many other law, treaties and regulation that mandate meaningful consultation. (Ninth District Court, Quechan Tribe v. US Department of Interior 2010)*

In addition, the following excerpt from a September 17, 2012 letter to the Commission from Maura Sullivan, a member of the Coastal Band of the Chumash Nation, provides an additional description of some of the concerns of the Chumash community regarding the anticipated adverse project related impacts to marine mammals:

> *The dolphins and whales are our relatives. When crossing the Santa Barbara channel for our annual Tomol crossing we encounter these blessed creatures and immediately our community erupts in applause and songs and prayers of gratitude. The animals are more than creatures with whom we cohabitate. These spirits are our guides and our caretakers. They teach us how to move through our lives in a fluid and graceful way. We cannot live without them.*
>
> …
>
> *We consider all of these animals, from the whales down to the tiny krill on which they feed, to be valuable resources in our community. This letter is in direct support of the NCTC (Northern Chumash Tribal Council) and the Northern Chumash peoples' rights to protect their environment and the sea creatures as a cultural resource. This is summarized in article 26 of the UNDRIP:*

> *Article 26*
> *1. Indigenous peoples have the right to the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired.*
> *2. Indigenous peoples have the right to own, use, develop and control the lands, territories and resources that they possess by reason of traditional ownership or other traditional occupation or use, as well as those which they have otherwise acquired.*
> *3. States shall give legal recognition and protection to these lands, territories and resources. Such recognition shall be conducted with due respect to the customs, traditions and land tenure systems of the indigenous peoples concerned.*

The Chumash community thus considers marine mammals to be important cultural resources. Dolphins have a particular importance to the Chumash people because their origin story, the story of the Rainbow Bridge, establishes that dolphins and humans are descended from one people. Mati Waya of the Chumash Nation's Sea Turtle Clan on the Wishtoyo Foundation website, states:

> *As the Rainbow Bridge story tells it, when the Chumash crossed over from the islands to the mainland, on the Rainbow Bridge, the Creator told them not to look down, or they would die. However, some could not resist. Instead of letting them die, the Creator saved them, turning them into Dolphins.*

Although the Coastal Act does not provide a policy basis for protecting cultural resources in the absence of an identification by SHPO that archaeological or paleontological resources are present, the Commission, in the Marine Resources section of the report (Section G), evaluated this project's impacts to dolphins and finds that it will result in significant adverse impacts to dolphins and other marine mammals, and therefore is inconsistent with the Coastal Act's marine resource protection policy (30230). However, with respect with to the Coastal Act cultural resource protection policy, the Commission finds the project consistent with Section 30244.

K. ENVIRONMENTALLY SENSITIVE HABITAT AREAS

Coastal Act Section 30240(b) states that:

> *(b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.*

In addition, Coastal Act Section 30107.5 defines "Environmentally sensitive area" as follows:

> *"Environmentally sensitive area" means any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments.*

The proposed project includes the temporary placement of approximately 90 passive seismic monitoring devices (geophones) on sandy beach area along a 5.53 mile linear transect on the Morro Bay Sandspit (0.81 miles within Montana de Oro State Park (MDOSP), 3.51 miles within Morro Dune Natural Preserve (MDNP), and 1.21 miles on non-park property). Each geophone is small (5-pounds, 6-inches-high, and 5-inches-wide with a 5-inch spike located at the bottom of the device to assist in placement) and will be placed 100 meters apart along the beach and buried about one foot to avoid trampling and vandalism (see Exhibit 2 for the transect location and Exhibit 3 for a diagram of a typical geophone nodal). The geophones would be removed when the survey is complete. All work associated with the onshore geophone -- placement, maintenance, and removal – would be conducted manually without the use of heavy equipment on the beach.

The area of the Morro Bay Sandspit where geophones are to be placed is composed of coarse-grained sand. The wildlife habitat associated with this sandy beach area is barren with generally less than 2 percent vegetative cover. Many bird species nest in this barren habitat along the coast, including the western snowy plover (Charadrius alexandrinus nivosus), a Federal-threatened species, and other plovers, stilts, avocets, several gulls, and terns including the California least tern (Sternula antillarum), a Federal-endangered species, but the project would be carried out during the non-nesting season.

Areas landward of the Morro Bay Sandspit sandy beach area include coastal foredunes and central dune scrub, habitats that are rare and sensitive and qualify as environmentally sensitive habitat areas (ESHA) under the Coastal Act. These habitat areas are inhabited by many small mammal species, including the Botta's pocket gopher, California mouse (Peromyscus californicus), and western harvest mouse (Reithrodontomys megalotis). Bird species that inhabit central dune scrub include California towhee (Pipilo crissalis), rufous-sided towhee (Pipilo erythropthalmus), white-1 crowned sparrow (Zonotrichia leucophrys), wrentit (Chamaea fasciata), California thrasher (Toxostoma redivivum), and scrub jay (Aphelocoma coerulescens). Reptiles include southern alligator lizard (Elgaria multicarinata), western skink (Eumeces skiltonianus), and western fence lizard (Sceloporus occidentalis). Special-status species that may occur in this habitat include the federally protected Morro shoulderband snail (Helminthoglypta walkeriana), the Federal- and State-endangered salt marsh bird's beak (Chloropyron maritimum ssp. maritimum), Blochman's leafy daisy (Erigeron blochmaniae), and the State-threatened beach spectaclepod (Dithyrea maritima).

In order to avoid impacts to sensitive habitats and species (especially the sensitive dune vegetation located inshore of the beach on the Morro Bay Sandspit) that could result from the temporary placement, operation, and removal of the geophones, PG&E has incorporated the following design features and mitigation measures into the project:

- A worker environmental awareness training program would be conducted to discuss the area's sensitive species, habitat areas, and mitigation measures.
- Pre-activity biological surveys of area to be conducted by a qualified biologist no more than two weeks prior to the start of onshore activities and submitted to the Coastal Commission and other agencies. Areas with sensitive flora and fauna would be recorded with GPS, clearly marked in the field, and have an exclusion zone established around them.

- A qualified biologist would be maintained on site during placement and retrieval of the geophones to ensure exclusion areas are maintained and sensitive resources are avoided.
- The geophones would be placed above the high high-water mark in areas devoid of vegetation on the side of trails in areas that do not contain sensitive species or habitat.
- Exclusion zones would be established around kangaroo rat burrows and any presence of Morro shoulderband snail (50 feet).
- Areas within Montana de Oro State Park and the Morro Dune Natural Preserve would be accessed by foot from the southern sandspit parking lot or by boat from a more central location.
- Onshore project activities would not occur during the nesting.
- Burial of geophones will be done with hand tools only. No heavy equipment would be used.

With implementation of these measures, the Commission believes PG&E will avoid disturbing ESHA and sensitive species. The Commission therefore finds the project would be carried out consistent with Section 30240(b) of the Coastal Act.

L. OIL SPILLS

Section 30232 of the Coastal Act states:

> *Protection against the spillage of crude oil, gas, petroleum products, or hazardous substances shall be provided in relation to any development or transportation of such materials. Effective containment and cleanup facilities and procedures shall be provided for accidental spills that do occur.*

The proposed project includes the operation of three ocean vessels that could potentially increase the chance of a vessel collision and a release of fuel oil into marine waters during mobilization, demobilization, and survey activities.

The first test of Coastal Act Section 30232 requires an applicant to "protect against the spillage of crude oil, gas, petroleum products, or hazardous substances..." In this case, PG&E has incorporated into its project a number of measures that reduce the risk of an oil spill. To avoid the potential for a vessel collision, PG&E will provide a Notice to Mariners and local fishing associations prior to the start of field operations. The use of support boats during the project will minimize the potential for non-project vessel interference. Additionally, project vessels will not refuel within the project area in order to avoid the potential for releases during on-water fuel transfers.

With implementation of these measures, the Commission finds that PG&E is undertaking appropriate measures to prevent a spill from occurring and therefore the project is consistent with the first test of Coastal Act Section 30232.

Notwithstanding implementation of the above-described prevention measures, accidental spills can and do occur. The second test of Section 30232 requires that effective containment and cleanup facilities and procedures be provided for accidental spills that do occur. To meet this test the Commission requires an applicant to: (a) submit an oil spill contingency plan that

demonstrates that the applicant has sufficient oil spill response equipment and trained personnel to contain and recover a reasonable worst case oil spill, and to restore the coastal and marine resources at risk from a potential oil spill; and (b) demonstrate financial ability to pay for all oil spill clean-up costs and resource damages in the event of an oil spill.

PG&E currently has in place a California Nontank Vessel Contingency Plan covering the *R/V Marcus G. Langseth* that has been approved by the California Department of Fish and Wildlife's Office of Spill Prevention and Response ("OSPR"). The nontank vessel contingency plan includes spill notification procedures and general oil spill response and cleanup techniques. Oil spill equipment that would be available on-scene/onboard the *R/V Marcus G. Langseth* are identified in the Ship Oil Spill Response Kit, and include: 30 bags of dry absorbent, 12 absorbent socks 3"x4' long, 4 absorbent booms 5"x10' long, 2 bundles (100 per bundle) of absorbent mats 20"x15", and associated spill equipment (e.g., shovels, scoops, buckets, tape, goggles, gloves, etc.). In addition, a current and project specific list of contacts and spill notification numbers (including but not limited to: the identified Responsible Person/ Party, Cal-EMA oil spill reporting number, USCG, OSPR, and Port San Luis and Morro Bay Harbormasters) will be updated prior to the start of field operations and will be onboard *R/V Marcus G. Langseth* for the duration of the project. Moreover, PG&E has agreed in its oil spill contingency plan to include "protective measures developed to protect sensitive resources and habitats in the Project area, as described in the Area Contingency Plan (ACP) prepared by the USCG, California Department of Fish and Game, and other resource agencies" (see APM-27 – Oil Spill Contingency Plan). Over the years, Coastal Commission Oil Spill Program staff has been instrumental in developing and updating an ACP for this area that identifies area-specific coastal and marine resources at risk and area-specific oil spill response techniques and capabilities.

However, PG&E has not demonstrated the financial ability to pay for all oil spill clean-up costs and resource damages in the event of an oil spill. The implementing regulations, found in California's certificate of financial responsibility regulations (14 CCR Sections 791-797), require that, prior to operating in California, all operators or owners of marine facilities where a spill could impact the marine waters of the state must demonstrate to the satisfaction of the Administrator of the OSPR the financial ability to pay for all costs and damages caused by a spill. The OSPR Administrator issues a California Certificate of Financial Responsibility ("COFR") when the standards set forth in the regulations have been met. Even though PG&E's nontank vessel contingency plan has been previously approved by OSPR (January 24, 2011), PG&E, as the operator of nontank vessel *R/V Marcus G. Langseth*, has not received a COFR from the OSPR Administrator, making the plan and vessel "non-compliant." In order to ensure vessel and contingency plan compliance, the Commission could require PG&E to provide evidence that a COFR has been issued by the OSPR Administrator prior to the start of field operations.

With the addition of such a requirement, and given PG&E's implementation of the approved California Nontank Vessel Contingency Plan for the *R/V Langseth*, the Commission could find that PG&E would provide effective containment and cleanup equipment and procedures for accidental spills that may occur and that the project would satisfy the second test of Coastal Act Section 30232.

M. COASTAL DEPENDENT INDUSTRIAL OVERRIDE

Section 30260 of the Coastal Act states:

> *Coastal-dependent industrial facilities shall be encouraged to locate or expand within existing sites and shall be permitted reasonable long-term growth where consistent with this division. However, where new or expanded coastal-dependent industrial facilities cannot feasibly be accommodated consistent with other policies of this division, they may nonetheless be permitted in accordance with this section and Sections 30261 and 30262 if (1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible.*

Coastal Act Section 30101 defines a coastal-dependent industrial development or use as that which "requires a site on or adjacent to the sea to be able to function at all." Ports, offshore oil and gas platforms, and power plants that require seawater for cooling are types of coastal-dependent development that the Coastal Act gives priority over other types of development on or near the shoreline. Coastal Act Section 30001.2 finds that, notwithstanding the significant adverse effects a coastal-dependent industrial development may have on coastal resources or coastal access, it may be necessary to locate such developments within the coastal zone. Consequently, Section 30260 of the Coastal Act provides for special consideration of coastal-dependent industrial facilities that may otherwise be found inconsistent with the Coastal Act's Chapter 3 policies. Coastal-dependent industrial facilities must be evaluated under all applicable policies and standards contained in Chapter 3. If the proposed project is inconsistent with any Chapter 3 policy, Section 30260 provides that the Commission may nonetheless approve such developments if it finds that the proposal meets that policy's three-part test.

PG&E proposes to conduct the seismic survey to provide the California Energy Commission, the California Public Utilities Commission, and the Nuclear Regulatory Commission with additional seismic data as part of its effort to re-license and therefore extend the operation of the Diablo Canyon Power Plant (DCPP). The Commission has previously determined the DCPP to be a coastal-dependent industrial facility, finding "While nuclear power plants in general are not necessarily coastal-dependent, DCPP's reliance on billions of gallons a day of seawater requires that it be sited on or adjacent to the sea in order to function at all, and it is therefore coastal-dependent." (See Commission's Final Adopted Findings for E-06-011/A-3-SLO-06-017 Diablo Canyon Steam Generator Replacement Project.)

As discussed in Section G of this report, the proposed project is inconsistent with the marine resources protection policies (Section 30230 and 30231) of the Coastal Act due to significant adverse impacts to marine mammals and other marine wildlife that cannot be mitigated. Since the survey to be undertaken is in support of the temporal expansion of an existing coastal-dependent industrial facility, the Commission may nevertheless approve the project if all three requirements of Section 30260 can be met. As discussed in detail below, the Commission finds that the project does not meet any of these tests, and it therefore cannot be approved pursuant to Section 30260.

Project Alternatives

The first test of Section 30260 allows the Commission to approve the project if it finds that "alternative locations are infeasible or more environmentally damaging." Since the Commission also is required under the California Environmental Quality Act (CEQA) to evaluate a reasonable range of alternatives if the proposed project results in significant adverse environmental effects, the Commission here analyzed a broad range of potential project alternatives, including alternative locations and configurations.

The Commission notes that the project currently proposed and evaluated in this report is itself an alternative version of the originally proposed project. In response to concerns raised by the National Marine Fisheries Service over potentially high levels of marine mammal "take" and requirements of the State Lands Commission, PG&E had reduced the original proposal evaluated in the EIR. On October 1, 2012, PG&E further modified the project to carry out surveys on only one of the four originally proposed survey "boxes," or areas, and to eliminate the use of seafloor geophones. The result of these modifications is that the total number of anticipated operational days in the water would be 33 (including mobilization of project vessels, deployment of air gun arrays and streamers, air gun testing, and active surveying), down from the 82 total days that were anticipated in the initial proposal and evaluated in the EIR. The total number of days of active air gun use (including equipment calibration, sound propagation model verification, contingency days, and surveying) has been reduced from 65 under the initial proposal evaluated in the EIR to 17 under the most recently modified proposal.

Background

The EIR evaluated a variety of survey configurations. These alternatives included a single survey "racetrack" covering a larger area between Cambria and Point Sal as well as configurations with one, two, and three, survey loops focused on different areas and targets. The currently proposed project includes one survey box, Box 4, and would be limited to the months of November and December only. The current proposed project, which would cover about 880 miles over approximately 12 days (not including the five days of air gun use for equipment calibration and sound propagation model verification), is therefore substantially smaller in size and shorter in duration than the five alternative survey footprint locations evaluated in the project EIR. Because the extent and duration of the adverse impacts associated with this project are directly related to the size of the survey and the number of survey days, all of the larger and lengthier alternatives discussed in the EIR are expected to be more damaging than the currently proposed project. The Commission therefore focused its assessment of alternatives on whether PG&E could obtain the necessary data using methods that would further decrease the survey's extent or duration.

In addition to considering alternative survey footprints to reduce the significant effects of the proposed project, the Commission also evaluated (1) the installation of seafloor geophones as a means of eliminating or reducing the number or length of nearshore survey lines; (2) using data collected from previous seismic surveys in the project area as a means of either eliminating the need for the project or reducing its size or duration; (3) using data collected from the recently conducted and ongoing onshore 2D seismic studies and recently conducted offshore low-energy 3D seismic surveys (carried out in 2011 and from August 20 to October 5, 2012) as a means of eliminating the need for the project, or reducing its size or duration; and (4) the use of alternative

survey techniques – such as a research vessel with the capacity to use more than four streamers, marine vibroseis devices, etc. These evaluations are provided below.

Seafloor Geophones

PG&E's initial project proposal included the use of seafloor geophones. PG&E stated in a July 9, 2012 letter to Commission staff that "Marine geophone or node locations were selected to 'fill in' nearshore areas where the *R/V Langseth* cannot survey due to shallow water <25 m (82 feet) and other navigation obstacles." In other words, the use of geophones was proposed as a means of extending the seismic imaging area beyond the area in which the air gun array was proposed to be used. As such, Commission staff requested additional information from PG&E regarding the potential use of additional seafloor geophones as a means of reducing the proposed amount of nearshore survey activities. PG&E provided the following response on September 14, 2012:

> *The spatial area of the proposed survey is dictated by the location of the geologic features being evaluated in the proposed study. In particular the Hosgri and Shoreline fault structures are located offshore; therefore, imaging these structures must be conducted in direct proximity to their locations. PG&E has carefully evaluated the use of additional onshore surveys and seafloor geophones as a means of reducing the number or length of nearshore or offshore survey transects. …The number or length of nearshore or offshore survey transects has been minimized to the extent feasible.* (emphasis added)

Commission staff then requested additional information regarding the evaluation that PG&E referenced in its letter regarding the use of additional onshore surveys and seafloor geophones to reduce the number or length of nearshore or offshore survey transects. PG&E responded (K. Vardas personal communication on September 14, 2012) that no written record of such an evaluation was available for review by Commission staff. PG&E has therefore not provided the Commission with information that would allow it to analyze the feasibility of using additional seafloor geophones. Subsequently, PG&E eliminated the use of seafloor geophones from its project, as reflected in the revised proposal submitted to Commission staff on October 1, 2012. The Commission finds this potentially feasible alternative needs further evaluation. The use of seafloor geophones may reduce the amount of survey activities and thereby reduce identified impacts to coastal resources through lowering the extent and duration of sound levels that would be received in the marine environment, particularly in highly productive and diverse nearshore habitat areas, water-oriented recreation sites, and fishing locations. As a result, the Commission finds that it has insufficient information to determine if a survey using seafloor geophones would result in a feasible and less damaging project alternative.

Use of Data from Previous Seismic Surveys

The collection, evaluation, and, if necessary, re-processing of previously collected seismic survey data using current methods has the potential to eliminate the need for the proposed project or reduce its scope or duration. Approximately 19 seismic surveys have been carried out in the project area since the early 1970s. These previous surveys have been carried out by government agencies, research organizations, the oil industry and PG&E. The table and figure included in Exhibit 8 to this report provide a brief summary of these previous surveys and shows the specific areas they targeted. In response to questions regarding whether or not the data collected during

these previous surveys could be used to reduce the duration, scope, or design of the proposed project, PG&E states that:

> *Diablo Canyon is the only nuclear power generating facility in the country that employs a full time seismic department staffed with experts. The scientific staff continually studies earthquake faults in the region of the power plant and global seismic events as part of a comprehensive safety program, known as the Long Term Seismic Program (LTSP). The LTSP is a requirement of our NRC operating licenses. The analyses and models used in the seismic assessments under the LTSP are continually updated and confirm the plant is designed to withstand probable ground motions from nearby faults.*
>
> *PG&E's advanced seismic research was called for by the state and includes the use of a combination of on-shore 2D and 3D studies, off-shore 3D low and high-energy surveys, as well as the ongoing use of seismic monitoring devices.*
>
> *The advanced studies will enhance our seismic knowledge of the area, and provide a more accurate, detailed picture of the region's seismic characteristics, including the angle of faults, how they are shaped and if they are interconnected. This data will help further define the ground motions that faults in the region are capable of producing, which PG&E will use as part of its ongoing work to continually assess and validate the seismic design of the plant. The data will also be used to support a federal requirement for a new seismic risk evaluation following the Fukushima Daiichi power plant tragedy.*

This response does not clarify the extent to which data resulting from these previous surveys has been collected, evaluated, and re-processed by PG&E using more modern techniques. In response to a request from Commission staff to PG&E for additional information on this issue, PG&E noted in a September 20, 2012 email to Commission staff that it has evaluated and discussed all of the seismic survey data collected during the surveys shown in Exhibit 8. PG&E's response refers to a variety of references in which the previously collected survey data was evaluated, the majority of which are well over ten years old. This suggests that a more recent evaluation making use of more advanced processing techniques that may currently be available has not been carried out. In addition, the September 18, 2012 decision by the CPUC to approve PG&E's request to recover in customer rates a total of $64.25 million to carry out 2D and 3D seismic studies onshore and offshore of DCPP provided specific funds for "purchasing and evaluating existing industry data" collected during offshore seismic surveys. PG&E suggested in subsequent communications with Commission staff that the data purchased was onshore data only and it was used to inform the design of the onshore 2D seismic imaging program.

This issue is of key importance to a consideration of the proposed project because the extensive amount of seismic data collected in the vicinity of DCPP over the past 40 years has the potential to be used to further refine the proposed project and change the location or reduce the size and duration of survey efforts – modifications that would reduce anticipated significant and adverse impacts to coastal resources and identified conflicts with the Coastal Act. The Commission believes that a re-evaluation of older data, in conjunction with completing the assessment of

recently acquired 2D and 3D low-energy survey data (as discussed below), has the potential to further reduce the survey location, scope, or duration.

Use of Data from Recently Conducted and Ongoing Studies

The proposed project is one element of a $64 million, multi-year seismic research program initiated by PG&E in 2010. Other elements include partially-completed extensive onshore seismic imaging efforts in Los Osos, San Luis Obispo County, and the vicinity of DCPP as well as several separate 2D and low-energy 3D offshore surveys and the installation of long-term seismic monitoring devices on the seafloor.[16] The following excerpts from the recent September 18, 2012 CPUC funding decision for this work provide a brief description of its scope and objectives:

> *In addition to more than doubling the offshore area to be studied using 2--D and 3--D technology, PG&E is performing two types of 3--D seismic surveys: high--energy and low--energy. The low--energy survey provides high--resolution imagery at subsurface depths of approximately 1/2 kilometer (km). The high--energy survey provides imagery at depths of up to 12 km, but provides poor resolution imagery at shallow depths, so the high-- and low--energy technologies complement each other. PG&E plans to perform high-- and low--energy 2--D and 3--D surveys to illuminate shallow and deep structures and resolve uncertainties related to the Shoreline, Los Osos, and Hosgri/San Simeon fault zones. Understanding the geometry of these faults at seismogenic depths, coupled with slip rate information that PG&E hopes to obtain from the low-energy surveys will improve PG&E's ability to define the seismic hazard in the region.*
>
> *...*
>
> *PG&E identified the Los Osos and San Luis Bay fault zones as having a deterministic seismic hazard that was comparable to the offshore Shoreline and Hosgri fault zones. Reducing the uncertainty in the source characterization (geometry, slip rate) of these fault zones will further define the seismic hazard at Diablo Canyon. Additionally, the data collected from the onshore 2--D surveys will provide constraints on the geometry and style of faulting beneath the Irish Hills. Using this data, PG&E will develop a 3--D model of the geologic structure beneath the Irish Hills to address the geometry and rate of uplift of the hills and the distribution of hypocenters beneath the range. PG&E determined that it should implement 2--D seismic surveys rather than 3--D surveys onshore because of the difficulty and cost of using instruments in rugged hilly terrain, as well as land ownership and environmental issues.*
>
> *Even then, the highly folded and deformed nature of the rocks in the Irish Hills region limits the resolution possible with conventional 2--D seismic surveys. In light of that reality, PG&E conducted computer--based illumination studies to optimize the proposed onshore source and receiver routes, which caused PG&E to modify the four survey routes it had originally proposed. This revised survey plan covers approximately 2.5 times the mileage originally proposed in 2010 and uses two types of seismic sources: (1) Vibroseis trucks for deep (approximately 10 km) penetration; and (2) Accelerated Weight Drop trucks for shallow (approximately 5 km) penetration and infilling in areas that the larger Vibroseis*

[16] In April 2012, PG&E received Commission approval to install these devices, known as "Ocean Bottom Seismometers" or OBS units; however, PG&E has not yet done so.

trucks are unable to access. The additional line mileage, the deployment of geophones, and the use of two different types of seismic sources will enable improved imaging of fault structures at depth that will approach the resolution of conventional 3--D seismic coverage.

While PG&E has indicated that these projects and the proposed high-energy offshore survey are directed at separate targets and research questions, the review and analysis carried out by the Independent Peer Review Panel (IPRP) suggests that some of the other data being collected may shed light on the high-energy offshore targets as well, potentially causing the project location, scope, and duration to be further refined. Specifically, after carrying out its review of PG&E's proposed project targets and objectives as well as the available information for the project area, the IPRP recommended that PG&E eliminate its proposed northern survey area, survey box 3, because recently conducted low-energy surveys provided sufficient information to satisfy the remaining questions and scientific debate regarding the research targets in that area. PG&E ultimately agreed and dropped Box 3 during the CSLC review of the project, subsequently reducing the survey size by approximately 25% (based on the initially proposed survey of four separate boxes). This suggests that the not-yet-completed evaluation of the low-energy offshore data and 2D onshore data collected by PG&E over the past two years may also further refine and reduce the extent and duration of the proposed survey. PG&E expects to complete the data processing for those surveys in early to mid-2013, which will likely help inform any high-energy offshore seismic survey proposed for the fall of 2013. Even a small reduction in the survey area or duration has the potential to substantially reduce the impacts associated with the project. PG&E may also obtain additional guidance on the necessary scope of its seismic surveys through the Nuclear Regulatory Commission's Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 review process. PG&E is currently participating in this process as part of its application for relicensing. As part of this process, an independent panel of experts analyzes available seismic data to evaluate the seismic hazard at DCPP and determines if additional data should be gathered and how it should be gathered. The results of this data analysis phase of the SSHAC process are not yet available, so it is unclear if the experts involved in the SSHAC process will recommend seismic surveys in the location or of the length and scope proposed by PG&E.

Therefore, until the other elements of PG&E's seismic research program (low-energy offshore surveys and onshore seismic imaging) can be completed and their results evaluated, and until more is known about the recommendations generated through the SSHAC process, the Commission is unable to determine whether the proposed project could be further refined in location, scope, or duration. We note that PG&E has modified the survey at least six times in roughly the past six months, with modifications as recently as October 2012, even before completing the processing and evaluation of the recently acquired data. This suggests further refinements and further reductions of the survey and its impacts are likely. The Commission therefore finds that insufficient information is currently available to analyze whether further refinements will lead to a feasible and less environmentally damaging alternative to the proposed project. Thus, insufficient information is available for the first "test" of Section 30260 of the Coastal Act to be met.

Alternative Survey Techniques

There is also the possibility to use alternatives to air guns and alternative means of collecting data using high-energy air gun surveys.

In a letter to the Commission dated September 17, 2012, the San Luis Obispo County Board of Supervisors, questioned whether an oil industry vessel capable is using 10 streamers instead of four streamers (as proposed by PG&E) may be a better alternative that results in less survey days and therefore less coastal resource impacts. The letter states:

> *…. The proposed survey vessel would tow 4 laterally-separated streamers of hydrophones, covering a swath of 300-400 m of ocean surface with each pass of the survey vessel. In contrast, industry vessels can tow 10 or more streamers similarly spaced, resulting in a swath about 1000 m wide. As noted in PG&E's response (Attachment 2), the greater number of streamers "can reduce data collection time by a factor of 2 or 3."*
>
> *PG&E contends, but has not demonstrated, that operation of a 10-streamer boat is not feasible in this survey area. The question should be settled by an industrial-level survey design review, which would model data acquisition geometry based on state-of-the-art streamer positioning technology. While the issue of data collection efficiency is certainly important because of reduced survey time would reduce impacts to marine life, the larger streamer numbers and other industrial survey technologies could also improve the image quality of the geologic targets.*

The need for further evaluation of this alternative data acquisition method has been repeatedly raised by the IPRP in its reports as well as by the California State Lands Commission during its consideration of PG&E's application for a Geophysical Survey Permit. In addition, the CPUC has provided $210,000 to San Luis Obispo County to expedite the addition of one or more experts to the IPRP with sufficient technical knowledge to carry out a review of the feasibility of alternative streamer/vessel configurations. To date, this review has not been completed. As such, the Commission does not currently have sufficient information regarding the feasibility and potential impact reduction qualities of this alternative to make a determination that it would not be a feasible, less environmentally damaging alternative to the proposed project. As noted by Supervisor Gibson in Attachment 3 of the September 17, 2012 letter from the San Luis Obispo County Supervisors to the Commission:

> *This project should be submitted for a complete survey design review that would include a navigational obstruction survey of the area and modeling of streamer tracking behavior (horizontal and vertical) based on modern streamer steering and control technology. The survey design review would assess data collection efficiency, including 1) the potential use of greater numbers of streamers, and 2) the application of a second shooting boat, which is a common industry practice that improves data collection efficiency and image quality as well.*

The Commission agrees that this survey design review should be carried out in order to identify potential acquisition or processing modifications that could be made to decrease the duration or scope of the proposed project. Until the results of this independent third party review process are available and evaluated, the Commission is unable to determine whether the proposed project could be further refined in scope or duration. As such, the Commission finds that insufficient information is currently available for this project alternative to be rejected as one that would be either infeasible or more environmentally damaging than the proposed project. The Commission

therefore finds that insufficient information is available for the first "test" of Section 30260 of the Coastal Act to be met.

In addition, the EIR includes a detailed discussion and analysis of a variety of other non-air gun technologies, including microseismic and passive seismic monitoring, electromagnetic surveys, controlled-source/marine vibroseis technologies, and deep-towed acoustics/geophysical systems. The EIR concluded that all of these technologies have limitations that would make their use infeasible at this time. The Commission has carried out an additional review of these technologies and also finds that none of them would be feasible alternatives to the proposed use of air guns.

No Project and "No Project At This Time" Alternatives
As discussed in Section G of this report, the proposed project is inconsistent with Coastal Act policies designed to protect marine resources. Thus, the no project alternative would clearly have fewer adverse environmental impacts than the proposed project. The question remains, however, whether this alternative meets the purpose of the project. Another, related, alternative is essentially the "no project at this time" alternative. This alternative allows PG&E and the Commission to fully evaluate existing and recently gathered data to determine whether a project of the location, size and scope proposed by PG&E is necessary to meet PG&E's data acquisition goals.

These alternatives would not involve the immediate implementation of seismic surveys. Instead, PG&E would use existing information and analyses to assess seismic features, movement, and hazards. This information would include:

- Data collected to date and incorporated into existing reports, such as PG&E's Shoreline Fault Report (PG&E 2011).
- Data that are currently being collected as part of PG&E's Long-term Seismic Program, including the results of the low-energy survey carried out in 2011 and 2012; and
- Data and reports prepared by other agencies and organizations such as the United States Geological Survey.
- A third party review of proposed survey data acquisition and processing.

Based on the evaluation of these data, PG&E may then be able to propose a refined and reduced survey. Additionally, these evaluations may result in sufficient reduction of uncertainty about the seismic characteristics of the area and potential effects on DCPP that a high-energy offshore survey may be unnecessary, making the no project alternative a feasible alternative.

Conclusion on Alternatives
For the reasons described above, at this time the Commission lacks sufficient information necessary to find that alternative project locations, or other alternatives, are infeasible or more environmentally damaging and that the first test of Section 30260 has been met.

Public Welfare
The second test of Section 30260 involves public welfare considerations, and the question of whether *not* authorizing the project to proceed "would adversely affect the public welfare." In weighing the public welfare considerations, the Commission finds that the project's impacts on

marine resources would be adverse and significant, for the reasons discussed in the previous sections of this report, whereas the benefits to be gained from performing the surveys remain unclear.

The primary stated goal of the survey is to reduce uncertainty over the likelihood and intensity of seismic events. Even if the survey is conducted, however, uncertainty will remain. The Commission notes, for example, that earthquakes occur after significant pressure has built up in a fault zone; however, the survey would not be able to measure or predict the amount of pressure that has built up on a fault. Furthermore, PG&E stated it is "highly unlikely" that the plant would need to be retrofitted in the event increased risk to the plant is predicted due to the surveys, and even if retrofitting were necessary, PG&E has not provided any information as to whether and how such retrofitting might occur or be feasible. Moreover, it is unclear whether increased earthquake magnitude potential would necessarily lead to increased risk to the plant, in part because such an increase in predicted magnitude could be accompanied by a reduced frequency of seismic events.

Therefore, given the evidence provided to date, the Commission is not convinced as to the benefits to be derived from the survey information, whereas the project would significantly adversely impact marine resources. The Commission therefore concludes that it has insufficient information at this time to determine that not authorizing the project would, on balance, adversely affect the public welfare, and thus that it has insufficient information available to find the project consistent with the second test of Section 30260.

Maximum Feasible Mitigation

The third test of 30260 requires a finding that the adverse environmental impacts of a proposed project have been mitigated to the maximum extent feasible. As discussed in the previous sections of this report, in several issue areas the Commission has determined that it has insufficient information to determine whether adverse effects would be adequately mitigated. Specifically, PG&E's proposed marine mammal and fish monitoring programs are deficient, so, as proposed, the actual impacts to marine mammals and fish will not be accurately assessed. And even if the scope of the project's impacts on these species were determined, PG&E has not proposed any mitigation, much less the maximum feasible mitigation, for impacts to fish or marine mammals, particularly the Morro Bay stock of the harbor porpoise. Thus, the Commission finds that there is inadequate information in the record for it to determine if these impacts will be mitigated to the maximum extent feasible.

In addition, the Commission finds that PG&E's proposed project does not adequately mitigate expected impacts to commercial and recreational fishing. The project would result in significant short-term and long-term impacts to commercial and recreational fishing, and while PG&E has proposed a communications plan and a fishing mitigation plan, neither plan is detailed enough for the Commission to assess whether the proposed mitigation would be adequate to meet the requirements of Coastal Act section 30234.5. The Commission similarly cannot find that there is sufficient evidence to show that the project would include maximum feasible mitigation for impacts to commercial and recreational fishing.

Finally, as described in detail in Section II.I above, the proposed project would have significant adverse effects on public access and recreation. PG&E's proposed communications plan does

not provide sufficient efforts or measures to provide adequate, updated, and complete noticing to the public in the project area regarding the location, timing, duration, and sound levels associated with the proposed project. Without a more detailed communications plan and a plan to provide mitigation for the project's impacts on lost recreational opportunities, the Commission finds that it has insufficient information to determine that the project's impacts on public access and recreation would be mitigated to the maximum extent feasible.

For these reasons the Commission concludes that it has insufficient information to determine whether adverse effects would be mitigated to the maximum extent feasible, and thus that the project is consistent with the third test of Section 30260.

N. CALIFORNIA ENVIRONMENTAL QUALITY ACT

Public Resources Code (CEQA) Section 21080(b)(5) and Sections 15270(a) and 15042 (CEQA Guidelines) of Title 14 of the California Code of Regulations (14 CCR) state in applicable part:

> *CEQA Guidelines (14 CCR) Section 15042. Authority to Disapprove Projects*. [Relevant Portion.] *A public agency may disapprove a project if necessary in order to avoid one or more significant effects on the environment that would occur if the project were approved as proposed.*
>
> *Public Resources Code (CEQA) Section 21080(b)(5). Division Application and Nonapplication. …(b) This division does not apply to any of the following activities: …(5) Projects which a public agency rejects or disapproves.*
>
> *CEQA Guidelines (14 CCR) Section 15270(a). Projects Which are Disapproved. (a) CEQA does not apply to projects which a public agency rejects or disapproves.*

Section 13096 (14 CCR) requires that a specific finding be made in conjunction with coastal development permit applications about the consistency of the application with any applicable requirements of CEQA. This report has discussed the relevant coastal resource issues with the proposed project. All public comments received to date have been addressed in the findings above. All above findings are incorporated herein in their entirety by reference. Section 21080(b)(5) of the CEQA, as implemented by Section 15270 of the CEQA Guidelines, provides that CEQA does not apply to projects which a public agency rejects or disapproves. The Commission finds that denial, for the reasons stated in these findings, is necessary to avoid the significant effects on coastal resources that would occur if the project was approved as proposed. Accordingly, the Commission's denial of the project represents an action to which CEQA, and all requirements contained therein that might otherwise apply to regulatory actions by the Commission, do not apply.

Outlook

Geophysical seismic surveys off Central California to study Cross-Hosgri fault 2

From mbcfo member <mbcfo1972@gmail.com>
Date Tue 08/19/2025 06:55 AM
To FGC <FGC@fgc.ca.gov>; Miller-Henson, Melissa [redacted]>

Here is a link to the USGS mapping project mentioned in prior email: https://www.usgs.gov/centers/pcmsc/science/california-seafloor-mapping-program

Tom Hafer
Secretary MBCFO
[redacted]
mbcfo1972@gmail.com

Outlook

Trump's Transportation Secretary Sean P. Duffy Terminates and Withdraws $679 Million from Doomed Offshore Wind Projects | US Department of Transportation

From mbcfo member <mbcfo1972@gmail.com>

Date Fri 08/29/2025 09:15 AM

To Doug Boren <douglas.boren@boem.gov>; CentralCoast@Coastal <CentralCoast@coastal.ca.gov>; Andrea Chmelik <Andrea.Chmelik@asm.ca.gov>; Dobroski, Nicole@SLC <Nicole.Dobroski@slc.ca.gov>; Eckerle, Jenn@CNRA <Jenn.Eckerle@resources.ca.gov>; Executive Officer of SLC <ExecutiveOfficer.Public@slc.ca.gov>; ExecutiveStaff@Coastal <ExecutiveStaff@coastal.ca.gov>; FGC <FGC@fgc.ca.gov>; Flint, Scott@Energy <Scott.Flint@energy.ca.gov>; bgibson@co.slo.ca.us <bgibson@co.slo.ca.us>; Greg Haas <greg.haas@mail.house.gov>; Nancy Hann <nancy.hann@noaa.gov>; Harland, Eli@Energy <Eli.Harland@energy.ca.gov>; Dr. Caryl Hart <CommissionerCHart@coastal.ca.gov>; Gonzalez, Kathleen@Waterboards <Kathleen.Gonzalez@Waterboards.ca.gov>; Huckelbridge, Kate@Coastal <Kate.Huckelbridge@coastal.ca.gov>; Kalua, Kaitlyn@CNRA <Kaitlyn.Kalua@resources.ca.gov>; Kato, Grace@SLC <Grace.Kato@slc.ca.gov>; Zara Landrum <zlandrum@morrobayca.gov>; Liu, Serena@Waterboards <Serena.Liu@waterboards.ca.gov>

This includes funds for Offshore Wind port at Humboldt.

Trump's Transportation Secretary Sean P. Duffy Terminates and Withdraws $679 Million from Doomed Offshore Wind Projects
transportation.gov

Tom Hafer
Secretary MBCFO
[redacted]
mbcfo1972@gmail.com

CALIFORNIA STATE FISH & WILDLIFE COMMISSION

Wednesday July 30, 2025

Dear Commission,

It is with great concern that I write this letter to you. It was stated in the newspaper that you were going to use "NON-LETHAL METHODS" to control Predators. Non-lethal methods do not work. They have been tried many times in many places on many types of destructive predators & birds. Eventually the target animal gets use to the technique being used and ignore it. Then we are right back to no control with all of the time & effort wasted. Trying to use non-lethal control of predators is like trying to walk with a rubber crutch, it does not work.

I learned that early in life. I had a black cat. My brother had a hen with 12 baby chicks. Every day one of his chicks disappeared. My mother said, "I think your cat is getting Cliffords baby chicks!" I said, "No! Not my cat!" I was four years old & was assigned to watch the baby chicks. By now we were down to four baby chicks. My cat lived under the back step. The baby chicks were kept in the house @ night & turned out early every day. Next morning Clifford turned out his baby chicks. I perched myself on a rock wall where I could watch the movement of the chicks & the back step. After about an hour when my cat thought the coast was clear he bounded out from his hiding place and caught a chick & headed back under the step.

I reported to mom that she was right. My cat was the reason the baby chicks were disappearing. Mom said, "We'll have to get rid of your cat!" When the big boys got home they were assigned to get rid of my cat. They put my cat inside of a gurney-sack & took him up on the hill above the house. I was tearful, but I knew it had to be done. The cat was jumping in the sack & headed back towards the house. Five boys were all shooting and the sack finally stopped moving. One of the bullets flattened one of the boys tires. That made me happy at the time, but I knew my cat had to be eliminated.

Let's take a look at what has happened to our wildlife since we started using NON-LETHAL control of predators in Surprise Valley. !) Rocky MT. Mule deer 4,000 head down to 23. 2) Pronghorn Antelope 577 hd. down to 11 (only one fawn) 3)Cotton tail rabbits 44 down to 2. 4) Jack rabbits thousands down to six. 5) Porcupines 84 down to one. (I didn't see the porcupine, but my dog found it one night) 6) Sage hens 24 down to 0. 7) Grouse 17 down to two. 8.) Mountain Quail 8 -covey's down to two. 9) Valley Quail 40 to 50 covey's down to 20 covey's 10+ 10) Pheasants. 160 down to "0"(Imports from China) 11) Chukars 20 covey's down to about four.(Imported from Asia in 1892)

As can plainly be seen NON-LETHAL control of predators does not work. Since predators have been protected by the State all of our game animals have suffered almost to the point of extinction. Mt. Lions, bears, Lynx & bobcats, coyotes, eagles, hawks and other predator- like animals have been stable or are on the increase.

In short you have done a poor job of what you have been commissioned to do! Let local people control the PREDATORS. It worked well for 200 years.

Sincerely,

Clayton Oilar

Clayton Oilar
Modoc County Game
Commission

Outlook

cost of chumming flag vs. cost of shark attack

From Jerry Taggart <[redacted]>
Date Sun 08/24/2025 05:36 PM
To FGC <FGC@fgc.ca.gov>

Hello FGC
Please consider adopting the Chumming flag in California. Or reach out to potus to sign an executive order officially adopting the Chumming flag in reducing shark attacks.
Thank you. GeraldTaggart https://www.chummingflag.com/ tps://grok.com/share/c2hhcmQtMg%3D%3D_aeade0b4-6577-4adc-9e61-b13240184e70

Outlook

Folsom lake stocking program

From Thomas Mailey <[redacted]>
Date Tue 09/02/2025 04:04 PM
To FGC <FGC@fgc.ca.gov>

Hi

I have no idea if this email is being sent to the right person, or people. But you have to start somewhere, right?

My name is Tom Mailey and I am interested in learning what it would take to possibly creating a net pen program for the stocking of rainbow trout and chinook salmon in Folsom lake. I know other lakes, like Berryessa and Camanche, have such programs and that they are overseen by private, non-profit groups.

My background: I have fished Folsom for salmon and trout for about thirty years. Five years ago I started a part-time fishing guide business, Get the Net. This past May, I retired from my career as a radio broadcaster (32 years as the morning co-host of the Pat and Tom show on KNCI in Sacramento) to take my fishing business full-time. Fishing is a lifelong passion, and the thing I've found since starting to guide is that I absolutely LOVE introducing people to the sport.

The thing I've also found (and feared from the get-go) is that Folsom is a tough lake to start people out on. It is, and almost always has been, an unusually unpredictable fishery. It's fine for bass. But I have fished it now since the mid-90s and the trout and salmon is a challenge. I've had a million conversations with others who call it their "home" lake and theories range from the lake's rapid draw-down and fill-up rates to over-predation of newly planted salmon and trout by bass, grebes and other predators. I personally think it's a combination of things: the lake's inconsistent levels certainly play a part, and there isn't much we can do about that. But I also think the fingerlings that get put in the lake are introduced too small, and predators have a field day. A net pen program could help solve that.

I admit I don't know much about net pen programs other than what I've seen and heard through conversations with acquaintances who help out with them at other lakes. But, I'm a quick learner, and I know several other anglers- some guides, most not- who would be interested in helping establish a program like that at Folsom.

Because the thing with Folsom is, while it is a challenge, the fish that do survive turn into absolute trophies - this summer we've been catching salmon planted in 2022 that are pushing 8 pounds. Salmon planted in '23 are 4-6 pounds. But, they're not huge numbers. There's a joke about catching

your "Folsom limit" - which is 1-2 fish per trip. And while seasoned anglers might be fine with fewer but bigger fish (if I'm by myself, I am), when you're trying to introduce people to the sport- esp parents with kids- I feel like we're missing a golden opportunity. This large, beautiful lake is at the doorstep of over 2 million people, and yet recreating on it, for most people, means Sea Doos and wakeboarding. If we want to be developing a base of anglers for 10, 20, 30 + years from now, by its proximity alone, Folsom should be the go-to. And yet it isn't. If I book a trip with a young family, I will do all I can to convince them to come with me to Collins lake, or Bullard's Bar, or Berryessa and if I do take them to Folsom, I have to issue a caveat. I know other guides do the same and a lot of sport anglers simply avoid the lake for trout and salmon altogether. It shouldn't have to be that way.

There are other facets of the lake's fisheries that bear examination too: the wild trout population, which is legitimately special. But that's for another conversation, if there ever is one.

I would love to hear thoughts/suggestions/admonishments about this idea. Just trying to see if this is a motor that can even be kicked into gear.

Tom Mailey
Roseville CA

Outlook

Fwd: Leave our bears alone and put stupid people in traps/cages--listen to us and work with us if you want successful programs

From Steve Rose <[redacted]>
Date Wed 09/03/2025 09:22 AM
To FGC <FGC@fgc.ca.gov>
Cc Steve Rose <[redacted]>

Melissa--we would really appreciate it if the commission would step up and do something about this addiction by the CDFW to kill anything they deem dangerous. Our Tahoe bears were here first and people have
overrun their home territory so now the state wants to kill them???what brilliant person makes those decisions. No one answers me when I ask so we are asking Gov Newsom to help us save them. You can help
us as well. Come to Tahoe and talk to locals. Thanks Steve/Vietnam Veteran/decades long local and wild animal advocate

---------- Forwarded message ---------
From: **Steve Rose** <[redacted]>
Date: Tue, Sep 2, 2025 at 12:53 PM
Subject: Leave our bears alone and put stupid people in traps/cages--listen to us and work with us if you want successful programs
To: R2Info@wildlife.ca.gov <R2Info@wildlife.ca.gov>, govpressoffice@gov.ca.gov <govpressoffice@gov.ca.gov>, David Jinkens <djinkens@cityofslt.us>, South Tahoe Now <paula@southtahoenow.com>, Heather Gould <[redacted]>, Ann Bryant <[redacted]>, cpedrosa@sacbee.com <cpedrosa@sacbee.com>, Laney Griffo <lgriffo@tahoedailytribune.com>, citycouncil@cityofslt.us <citycouncil@cityofslt.us>, Ingrid Newkirk, PETA <helpanimals@peta.org>, Heather Stroud <hstroud@cityofslt.us>, Joseph Irvin <jirvin@cityofslt.us>, Humane Society of the United States <connect@humanesociety.org>, Linda Tiramani <linda.tiramani@aspca.org>, grassroots@aspca.org <grassroots@aspca.org>, amoseidjord@tahoedailytribune.com <amoseidjord@tahoedailytribune.com>
Cc: Steve Rose <[redacted]>, 60m@cbsnews.com <60m@cbsnews.com>, sundays@cbsnews.com <sundays@cbsnews.com>

Morgan—Ann Bryant in South Lake Tahoe told me your people are still intending to kill bear #753 "Hope" and that is a
Mistake on your part. We are doing all we can to protect the wildlife of Lake Tahoe and it appears your

Group thinks they know better than those that live there. I told Peter I have lived in the same home in Bijou area for 30+ years. We have many bears in our neighborhood and have never had even one issue. They walk by my home weekly. I make sure we do not tempt
Them by washing out every single item of food packaging used, no dog food left out, no food stored in garage, no bird feeders and no
Garbage put out until morning of pickup. Stupid people that are clueless create the problem not the bears so they should
Not pay the price with their lives. We will not stand for California killing animals they label "dangerous" or a nuisance.
Ann has sanctuaries that will take bears that are trapped and the City Council is not allowing trapping inside the city
Limits per David Jinkins of the council. Work with us and cool the jets of your killing crew. I have asked the Governor to get
Involved in this issue as we consider our next moves against the State of California. Steve Rose/Vietnam Veteran/animal advocate

Outlook

Fwd:

From Steve Rose <[redacted]>

Date Thu 09/04/2025 11:40 AM

To South Tahoe Now <[redacted]>; eramos@tahoedailytribune.com <eramos@tahoedailytribune.com>; Heather Gould <[redacted]>; David Jinkens <djinkens@cityofslt.us>; citycouncil@cityofslt.us <citycouncil@cityofslt.us>; Robert Galloway <rgalloway@swiftcom.com>; Janice Stillions <[redacted]>; Wildlife R2 Information <R2Info@wildlife.ca.gov>; PETA Info <info@peta.org>; Ann Bryant <[redacted]>; Twallace@cityofslt.us <Twallace@cityofslt.us>; Heather Stroud <hstroud@cityofslt.us>; Joseph Irvin <jirvin@cityofslt.us>; Wilderness Watch <bretth@wildernesswatch.org>; brooke.laine@edcgov.us <brooke.laine@edcgov.us>; tburt.mcnaughton@mcnaughton.media <tburt.mcnaughton@mcnaughton.media>; Governor's Press Office <govpressoffice@gov.ca.gov>; Governor Joe Lombardo <newsletters@gov.nv.gov>; Adair Nowacki <adair@gmgvegas.com>; Maureen Nandini Mitra <editor@earthisland.org>

Cc Steve Rose <[redacted]>

This is a poster that should be in every short term vacation rental, stores, post office, ebike/ escooter rental place and used on BILLBOARDS in NEWSPAPERS CONSISTENTLY and magazines to cover all of the Lake areas. RADIO AND TV SPOTS WOULD BE A GREAT APPROACH AS WELL. Lets educate all people local and visitors and save our
bears, and all wildlife, from irresponsible bad habits and behaviors. BEARS/ANIMALS WERE HERE FIRST--IT IS THEIR HOME AND THEY NEED PROTECTION FROM PEOPLE NOT THE OTHER WAY AROUND. SR

---------- Forwarded message ---------
From: **Ian Mindling** <imindling@hs-business.com>
Date: Thu, Sep 4, 2025 at 11:19 AM
Subject: RE:
To: Steve Rose <[redacted]>

My pleasure. Have a great day!

-Ian

From: Steve Rose <[redacted]>
Sent: Thursday, September 4, 2025 11:08 AM
To: copy@hs-business.com
Cc: Steve Rose <[redacted]>
Subject:

Hey Ian--would you please send me the file for the Lake Tahoe Bear poster when you have time. Thanks Steve

SAVING THE BEARS OF LAKE TAHOE

The hungry bears of Lake Tahoe are always looking for an easy meal. Human food, garbage, pet food and even bird feeders, including humming bird feeders, will attract bears.

A bear's drive to eat will eventually overcome its fear of people and create issues. Properly bear proofing vacation homes and all homes in bear country will save our bear's lives.

How to eliminate bear conflict problems:

- Do not put trash outside the night before trash pickup.
- Rinse everything out before putting into trash, including paper plates, cups, tin cans, food bags and freeze scraps with odor.
- Spray inside of garbage bags with a household cleaner that will repel bears.
- Close and lock garage doors and windows nightly. Do not store food in garage.
- Install round door knobs in place of lever door knobs - yes, they know how to open them!
- Feed pets indoors and do not leave pet dishes outside at night.
- Only use bear resistant trash containers.
- When grilling meat, do not leave the food unattended, clean the grill, empty the drip pan and place bones/fat/gristle in a plastic bag and freeze until garbage day.
- If you compost regularly, turn the pile and add lime to reduce the odors.
- Put aways your bird feeders April 1 and do not put them back out until mid-November.
- Clean up all food/juice spills outside.
- Remove fruit from trees and berry bushes as soon as ripe.
- Put pine scented cleaner around doors, windows and steps/decks.

Other types of security available:

- Electric fencing around yard, gardens and trees.
- Bars/grills on windows (called burglar bars).
- Infrared motion detector attached to water sprays.
- Motion activated sound systems that simulate a barking dog.
- Motion sensor lighting can startle bears (or people).
- Shutter windows when away from home.

Teaching bears to stay away:

- If a bear comes close to your home, scare it by clapping your hands, banging pots together, or using an air horn.
- Keep bear spray on hand.

You can help keep our Lake Tahoe bears safe and have a great time in the mountains. Use common sense and common courtesy and love Lake Tahoe.

Bear League contact:

www.savebears.org
24 hour help/questions, call/text
530-525-7297
Email: bearsnsquirrels@sbcglobal.net

Outlook

General Public Comments

From Charlene Probst <charlene@parsec-corp.com>
Date Thu 09/04/2025 10:15 AM
To FGC <FGC@fgc.ca.gov>

Dear California Fish and Game Commission,

I have recently viewed a video on Instagram in which a blatant display of immoral hunting ethics was recorded for pleasure. This video was taken by Oscar Gomez in Riverside, California. Oscar had shot a coyote disabling her hind legs, believed to be female, leaving her helpless. The best she could do to seek safety was to try and drag herself, which she did. This is when Oscar released his dogs and instructed them to get her. He stood over the coyote filming with his phone while his dogs bit, ripped, chewed, and tore this coyote to death. It was a long and torturous death. Oscar later released the video of this coyote's pain, suffering, and death on several of his social media accounts.

It was further discovered that he had a hunting partner by the name of Enrique Martin Del Campo of KI-YI Predator Podcast in California. The experience is then shared on the podcast. There was a post on @kiyipredator titled kiyipredator Porn Hub Catagory called "Deep Penetration Coyote." On this podcast Oscar describes how his shot broke the coyotes back allowing him to set his decoy dogs onto the coyote for a prolonged period.

I do not believe that there is a hunter out there that would want Oscar Gomez and Enrique Martin Del Campo representing them. Please go to probstcharlene on Instagram for images and video.

Thank you,

Charlene Probst
PARSEC™

Parsec Automation Corp.
5515 E. La Palma Ave, No. 110
Anaheim, CA 92807 USA

P: +1 714 996 5302
F: +1 714 996 1845
cprobst@parsec-corp.com
parsec-corp.com

Outlook

Kern River Fly Fishers and Kern River Fly Fishers Council letters to Director Bonham re Kern River Concerns

From jimahren <>
Date Tue 09/09/2025 11:14 AM
To Cornman, Ari <>
Cc <>; <>; 'Jim Ahrens' <>; FGC <FGC@fgc.ca.gov>

Ari
I will see you one way or the other on this Thursday at the Meeting of the Wildlife Resources Committee. I may not be able to attend in person due to some personal issues. If not, I will be there via Zoom. I have attached copies of two letters that were sent over the weekend to Director Bonham. Both letters outline the concerns that the Kern River Fly Fishers Club and the Kern River Fly Fishers Council have about the Departments lack of concern in addressing significant long standing fishery issues on the Kern River. I will reference these letters and concerns in my remarks.
Please make copies of these letters and make them available to the Commissioners and staff who will be at the meeting. I would also appreciate it if you would make sure that the Executive Director of the Fish and Game Commission, Melissa Miller-Hanson, receives a copy of these letters so that she is aware of what is happening on the Kern River. I am also sending this to the general email address listed on the website.
In my view, the Commission has an obligation to address the Kern River issues raised in these letters under the Public Trust Doctrine and under the provision of the California Fish and Game Code 5937.
Thank you
Jim

James F Ahrens
Bakersfield CA

James F Ahrens
Board Member
Kern River Fly Fishers Council
[redacted]
Bakersfield California [redacted]

Charles Bonham
Director CDFW
P.O. Box 944209
Sacramento California 94244

Dear Director Bonham,

On behalf of Kern River Fly Fishers Council (KRFFC), I am writing to formally object to CDFW Region 6's support for Southern California Edison's proposed flow regime (WR-1) for the North Fork Kern River as part of the KR3 hydropower project relicensing. This 16-mile bypassed reach of the North Fork Kern – from Fairview Dam to Kernville – is a federally designated Wild and Scenic River segment with outstanding natural values and a high potential to support a cold-water trout fishery. Yet current conditions in this reach are severely degraded, and CDFW's current stance threatens to abandon the fishery in this river segment. We urge you to reconsider CDFW's position and advocate for scientifically sound flows that protect this river's ecological and recreational values.

Wild & Scenic River with Cold-Water Fishery Potential

The North Fork Kern River below Fairview Dam is recognized under the Wild & Scenic Rivers Act for its remarkable qualities, including cold, clear mountain water and historically abundant trout. The Upper Kern Basin Fishery Management Plan (1995) – developed by CDFW, USFS, NPS and others – explicitly states that *"The Kern River in this reach (downstream of Fairview Dam) is capable of producing a self-sustaining wild trout population when water temperature and flows are improved."* In other words, the only major barrier to a thriving cold-water fishery in this segment is the lack of sufficient flow and resulting high water temperatures. The 1995 Plan's directive was to increase flows in this reach to optimize wild trout production. KRFF and other stakeholders believe this goal remains both achievable and critically important. The North Fork Kern is one of the few streams in Southern California with habitat cool and clean enough to sustain trout – if given adequate water. Protecting and restoring this fishery aligns with CDFW's mission and the intent of the Wild & Scenic designation.

Poor Current Conditions in the Bypassed Reach

Unfortunately, current conditions in the 16-mile bypass reach are very poor for cold-water fish, as documented by both angler observations and recent studies. The reach has suffered from chronically low flows and elevated temperatures for decades, resulting in a

greatly diminished trout population. Local anglers routinely report seeing stretches of warm, shallow water with few trout. These observations are corroborated by the KR3 Project 2023 Fish Population Monitoring Report (Stillwater Sciences, Feb 2024). In fall 2023 surveys, biologists found alarmingly few wild trout in the bypassed reach – only *three naturally spawned* (wild) rainbow trout were captured in the entire reach below Fairview Dam. Nearly all other trout observed were recently stocked hatchery fish in the 6–12 inch range. Such results confirm that the wild trout fishery is virtually non-existent under current conditions.

Water quality data also indicate habitat stress. Summer water temperatures in the bypass routinely exceed 20ºC at the current minimum flows, in contrast to temperatures well under that figure above the dam. These warm temperatures correspond with low dissolved oxygen periods and violate the cold-water habitat criteria needed for trout. In effect, the bypassed reach experiences drought-like conditions *almost every year* due to flow diversion, severely limiting its ability to support trout.

Hydropower Diversion: Primary Cause of Degradation

The root cause of these degraded conditions is the KR3 hydropower project's large water diversion at Fairview Dam. KR3 is permitted to divert up to 600 cubic feet per second (cfs) of North Fork Kern flow into its tunnel, leaving only a small fraction in the natural river channel. Under current requirements, minimum instream flows (MIFs) in the bypassed reach range from just 40 to 130 cfs (depending on month) – even when hundreds of cfs are flowing above the dam. For example, during the 2023 fish survey, roughly 570–627 cfs flowed above Fairview Dam, but only ~80–84 cfs was left in the river below (near the mandated minimum). The enormous flow reduction has decimated the native fishery on the 16-mile stretch below the dam. Essentially, the KR3 project has been operating by creating a 16-mile artificial drought, year-in and year-out. It is beyond dispute that without sufficient water, this reach cannot sustain a healthy trout population.

Once-in-a-Generation Relicensing Opportunity

Sufficient water exists above Fairview Dam to dramatically improve conditions below. We are now in a once-in-a-generation opportunity to fix this problem. The KR3 hydropower project is undergoing Federal Energy Regulatory Commission (FERC) relicensing for a new 50-year license, with a decision expected by late 2026 . FERC has signaled it will re-license KR3 (decommissioning was dismissed), so the key question is how the project will operate for the next 50 years – in particular, how much water must be left in the river . This relicensing is likely the only chance in our lifetime to secure improved flows for the North Fork Kern. After the new license is set, the river's fate is effectively sealed for decades. We appreciate that CDFW has been a party to this process and has expertise in recommending ecological flows. We write to emphasize that now is the time for CDFW to champion meaningful increases in bypass flows that could restore the Wild & Scenic reach's cold-water fishery. The future of this river reach hangs in the balance.

Inadequacy of SCE's Proposed Flow Regime (WR-1)

Instead of improvements, the current proposal put forward by Southern California Edison (SCE) – called Measure WR-1 – would make conditions even worse in the critical summer period. Shockingly, WR-1 does not increase flows in any season; it simply redistributes the existing flow volumes, *reducing* summer minimum flows and slightly increasing spring flows when they are least needed (the MIF rarely comes into play during the spring runoff). This change directly targets the most sensitive time of year – late summer – when flows are desperately needed to keep temperatures down. Summer is when trout habitat is most vulnerable, yet SCE's plan would leave even less water in the river during heat of the summer. Meanwhile, adding a bit more flow in spring (when the river is naturally higher and cooler) provides little ecological benefit. In sum, WR-1 is a net negative for the trout fishery, offering no improvements and in fact heightening the stress on fish during late summer. It is difficult to imagine a less appropriate flow proposal for a purported Wild & Scenic, cold-water fishery stream — or one that is intended to support a put-and-take trout fishery, either.

It is deeply concerning that CDFW Region 6 staff have endorsed this inadequate flow regime. In public statements, CDFW Region 6 has argued that higher summer flows are not justified because of alleged habitat limitations. According to a May 2025 SJV Water article by Lois Henry, CDFW's Central Region Manager Gerald Hatlerclaimed that *"Even if you took the Fairview Dam out entirely, it wouldn't improve the native fishery that much."* He suggested that efforts should focus upstream of Fairview and that improving flows below the dam would be futile. In an email quoted in the article, Mr. Hatler further stated that *"further data analysis shows a self-sustaining cold-water fishery isn't possible below Fairview Dam."* In essence, CDFW Region 6 is asserting that this Wild & Scenic reach can never support a trout fishery, and is supporting a plan to give up on it.

KRFF strongly disagrees with CDFW's conclusion and its support of WR-1. The notion that removing Fairview Dam (thus restoring full flows) would "not improve the fishery that much" is contradicted by both common sense and CDFW's own documents. Ample evidence indicates that flow is the limiting factor: trout thrived in the Kern's cold waters historically. We find it troubling that CDFW would effectively write off 16 miles of prime river habitat without exhaustive study or public process. To our knowledge, no new comprehensive scientific study has been conducted to definitively conclude that a cold-water fishery is "not possible" below Fairview, and such a position is in direct conflict with CDFW's own management plan for this specific river segment. A truly scientific approach would explore what temperatures and oxygen levels would be at substantially higher flows (e.g. 200+ cfs) and whether trout could survive then (as they did historically) – not assume *a priori* that they wouldn't.

CDFW's Stance Contradicts Agency Mandates and Science

CDFW Region 6's current position and support for WR-1 are not only disappointing – they directly conflict with CDFW's own mandates, plans, and programs for the Upper Kern. We wish to highlight several contradictions:

- 1995 Fisheries Management Plan: The Upper Kern Basin Fishery Management Plan (CDFW et al., 1995) explicitly envisioned restoring a self-sustaining cold-water trout fishery in the reach below Fairview. It calls for *"optimizing trout production"* through improved flows and habitat. That plan, still in effect, has never been rescinded or revised through any public process. Abandoning its goals now – without stakeholder input or new peer-reviewed science – violates the spirit of the plan and erodes public trust. CDFW's current stance "flies in the face" of what its own management plan promised.
- Trout Stocking Program: CDFW actively stocks this very reach with hatchery trout for anglers, which absolutely undermines its claim that a fishery is not viable. In fact, portions of the North Fork Kern are managed as a "put-and-take" trout fishery – CDFW has regularly planted thousands of rainbow trout in the bypassed reach each year. If CDFW truly believed the habitat could never support trout, it would not continue stocking fish there. Those stocked trout cannot survive long let alone grow under present conditions; thus, CDFW's own stocking efforts will be in vain unless habitat (flows and temperature) is improved. It is inconsistent for the Department to invest in trout stocking and hatchery programs for this river while simultaneously surrendering on flow improvements needed for those trout to thrive. It is also against the Department plan to support the natural trout population that has been historically present but decreasing.
- California Environmental Flows Framework (CEFF): CDFW has been a leader in developing the CEFF, a science-based approach to determine ecologically protective flows in California streams. The CEFF collaboration (hosted by U.C. Davis) produced specific flow recommendations for rivers statewide – including the North Fork Kern below Fairview. According to the CEFF results (which CDFW helped create), baseflows of at least 230 cfs are needed in this reach to support its ecological functions in summer. CDFW's plan to reduce those flows to 100 cfs fall far below these science-based recommendations. CEFF was designed to create uniform, transparent environmental flow recommendations that reduce the sway of uneven resources or influence in individual proceedings. Adhering to CEFF here ensures the NF Kern is managed by the same science-based floor used statewide. It is difficult to reconcile CDFW Region 6's endorsement of maintaining 100 cfs in summer (or worse, cutting flows) with the Department's commitment to the CEFF and to using best-available science for flow management.

In light of the above, CDFW's support of SCE's WR-1 proposal appears as a "complete disconnect," to quote one stakeholder — a "total abdication" of the Department's responsibility toward the North Fork Kern. Abandoning a public trout fishery on a *Wild and Scenic River* – without exhausting all options to improve it – sets a dangerous precedent. We simply ask CDFW to do what its mission and prior commitments demand: protect and

enhance the fish and wildlife resources of this state, which in this case means advocating for flows that give the Kern River's wild trout a fighting chance.

Our Request: Don't Abandon the Kern – Recommend Protective Flows

KRFF respectfully requests that CDFW not abandon this reach and instead take a leadership role in restoring it. Specifically, we ask CDFW (under your direction) to withdraw Region 6's support for SCE's WR-1 flow regime and to submit scientifically grounded, ecologically appropriate flow recommendations for the North Fork Kern River to FERC. CDFW should be fighting for the river, not against it. At minimum, the Department should insist on increasing minimum flows consistent with the California Environmental Flows Framework. CDFW should lend its weight to flow regimes that *increase* instream flows (and thus river health) and reject those that decrease or perpetuate the status quo.

In conclusion, the Kern River below Fairview Dam is a precious resource at a crossroads. This is literally a once-in-50-years moment to correct decades of damaging dewatering . If we squander it, an entire generation of Californians will never know a healthy, trout-filled Kern River in this reach. KRFF urges CDFW to step up and be the strong conservation voice that this river needs. By advocating for robust instream flows and opposing WR-1, CDFW can honor its 1995 Plan, make full use of modern flow science, and give both wild trout and hatchery programs a chance to succeed. We ask for your leadership to ensure the North Fork Kern River is not written off but instead is restored as a cold-water fishery and Wild & Scenic River for future generations.

Thank you for your consideration of our concerns. KRFF and our partners are ready to assist CDFW in developing sound flow recommendations and monitoring plans for the Kern River. We would welcome further dialogue on this issue.

Sincerely,

James F Ahrens

Charles Bonham
Director
CDFW
P.O. Box 944209
Sacramento California
94244

I am writing on behalf of the Kern River Fly Fishers (KRFF), a 55-year-old club based in Bakersfield, California. For years, our club has been active in promoting conservation and fishing issues on the Kern River. We have been participants in various meeting on relicensing issues that affect both the Fairview Dam (KR-3) and Democrat Dam (KR-1). The Club has also been active in "The Bring Back the Kern" movement which is attempting to ensure year-round water flows in the Kern River through Bakersfield) For decades we have been working on re-introducing the Kern River Rainbow back into our local waters. Over these years our members have attended numerous CDFW hearings and meetings.

Recently an article, written by Lois Henry and published in SJV Water and in the Bakersfield Californian, quoted several CDFW staff members who gave their opinions about the management of the Kern River and the reintroduction of the Kern River Rainbow. I am responding to some of their comments and raising other KRFF concerns on how the river is managed by CDFW.

Let me begin by citing from the article what one Flyfisher believes to be CDFW's view of the Kern River. "The state treats that place like Area 51, everything is a damn secret." This is a description that KRFF agrees with. The Department is less than forthcoming about its role in restoring the Kern River to a viable fishery.

CDFW seems to be more interested in restoring the hatchery than it is in restoring the Kern River to anything close to a blue-ribbon trout river. The hatchery has not been operational for years. The Department has spent over one million dollars on wells and fencing and other projects. It now proposes to spend another $7 million to build a new syphon/pipeline to carry water to the hatchery. And by completing this project CDFW is approving the diversion of 35-40 cfs of cold water from the river where it should remain to help ensure that trout in the river survive. This project is justified by the Department alleging that it is necessary to restore the Kern River Rainbow to the Kern River.

The current year-round minimum water flows are inadequate The department should be aware that **Summer minimum-instream-flow (≈130 cfs) is only marginal.** During most summers, the North Fork of the Kern River (NFKR) is supposed to carry about **130 cubic feet per second (cfs)** in Section 5. At that flow, the river is barely deep enough to cover riffle rocks; trout hold mainly in the few remaining three-to-five-foot pools, and algae already begins to fringe shallows. Fishing is possible but limited.

Winter-level flows foreshadow summer harm. In late winter when natural baseflow is **50–90 cfs**. At those levels, the river is knee-deep or less through long stretches; trout habitat is scarce; and predatory birds have easy access. Cutting summer flows by 40 – 45 cfs pushes

the reach down into the same compromised winter state only now combined with hotter air and water. Increasing minimum flows are necessary to maintain the fishery.

CDFW is proposing to manage the North Fork of the Kern River as a transitional (cold->warm) fishery when its management plan states the fishery is capable of supporting a natural cold water fishery when flows are improved and states its overarching goal is to manage it to "optimize for trout production" CDFW is proposing to raise summer temperatures that are already too high for trout in wet years (with lower starting temps at Fairview Dam) and lower DO -- thereby making the reach more inhospitable for trout and undermining its own proposal to plant hatchery trout there (and thus insert them into an inhospitable environment, threatening their health growth and longevity. CDFW is ignoring its own science – The California Environmental Flows Framework (CEFF) which calls for much greater minimum flows in the fishery; CEFF was designed to identify the minimum flows required for ecological functioning and to standardize environmental flow recommendations. It appears to us that SCE is dictating these flow requirements and that CDFW is going along with this and refuses to utilize the CEFF template. If current KR3 operations are so unobjectionable, why must CDFW change management goals? The change in management goals is being slipped in w/o public participation or a justifying scientific document. The last two fish monitoring studies show the fishery to be in extremely poor condition, likely due to the hatchery flow exacerbating low flow conditions (and cratering WQ metrics) in 2015 and 2021.

The SJV article has this to say about the lack of Kern River Rainbow restoration. “When the first “Upper Kern Basin Fishery Management” plan was written in 1995, its goal was to avoid the Kern River rainbow having to be listed as threatened or endangered after it became a candidate for listing under the U.S. Fish and Wildlife Service. Since then, the fish has, in fact, become listed as a “species of concern” by the U.S. Forest service and California Department of Fish and Wildlife (CDFW).”

Thirty years have gone by since the first Upper Kern Basin Fishery Management plan was written and approved. When KRFF members ask anyone from the Department who is willing to talk about it, when the next management plan will be available for public comment, we are told that the Department is working on it. Come on. Thirty years and it has not been re-written? This tells me the Department is not interested in the Kern River.

Three years ago, a bushwhacking trek was made into some very remote areas of California to collect samples of what the researchers thought might be a locked in strain of the Kern River Rainbow. Samples were taken but we have not seen the results of this sampling. Two of your staff members are quoted as saying that they hope to have some of these results in a few weeks citing backlogs in the CDFW Lab. You might consider using some of that $7 million in siphon funding to contract the work out. It does not take three years to do a bioassay of these fish. One of your staff members is also quoted as saying that construction on the hatchery’s siphon and pipeline should begin by years end. Again, it seems to us that restoring the hatchery is more important than restoring the fishery.

I was also surprised to read that CDFW does not consider the sixteen miles of river running from the Fairview Dam to the power plant to be a prime trout river and that CDFW is content with the

water flow plan that has been proposed by Southern California Edison. KRFF believes that CDFW is more interested in what Southern California Edion proposes for river flows and is not interested in what advocates of the river like KRFF, and the Kern River Boaters have suggested as appropriate minimum year-round river flows.

If the Department does not consider the sixteen-mile stretch to be prime trout river but wants to rebuild the hatchery so that it can re-stock the Kern River rainbow, if ever found, where are you going to put the fish? The only part of the river to place trout is the stretch between the dam and the powerhouse. Statements like this from CDFW are ridiculous.

The following is a quote from the SJV article also quoting one of your staff that minimizes the need for adequate water levels and water flows.

“The greatest threat to Kern River rainbows isn’t water levels, its people overfishing and habitat loss. People are focusing on the wrong thing. There’s a bigger picture and below Fairview isn’t where it’s at. If something isn’t done, the long term outcome for Kern River rainbow trout is not good.”

KRFF would challenge that statement. There are many threats to the Kern River Fishery and the trout that are in the Kern River. Low water levels and mismanagement of the river are the prime reason for these threats. We would agree that people, overfishing, and habitat loss contribute to this. However, if the river was managed properly these issues could be mitigated. There is little to no warden presence on the river. Campsites are often overcrowded and given little attention. Volunteers often pick up the trash, If the Department can come up with $7 million dollars for a siphon/pipeline then the Department can certainly come up with the money to write a management plan that includes river flows based on scientific evidence and not on the suggestions of Southern California Edison.

I look forward to discussing these issues with you. Or if you prefer, KRFF would be happy to have a meeting with you and/or your staff to discuss these issues.

Thank you.

Larry Olagues
President
Kern River Fly Fishers
(661)873-5560

Outlook

Fwd: Wolves in Sierra Valley, Letter to Director Bonham mailed today.

From Jim <[redacted]>
Date Tue 09/09/2025 01:00 PM
To FGC <FGC@fgc.ca.gov>

Begin forwarded message:

From: Jim <[redacted]>
Subject: Wolves in Sierra Valley, Letter to Director Bonham mailed today.
Date: September 9, 2025 at 12:54:57 PM PDT
To: gfgc@fgc.ca.gov

Attn: Ms. Melissa Miller-Henson:

Attached is a letter I mailed to Director Bonham today. I am just trying to get a copy to all concerned. Thank you.

Sincerely,

Jim Magill

September 8, 2025

James W. Magill
[redacted])
Cromberg, CA [redacted]

Mr. Charlton H. Bonham, Director
California Department of Fish and Wildlife
P.O. Box 944209
Sacramento, CA 94244-2090

Dear Director Bonham:

I am a 76 year old, 10 year full time resident of Plumas County. I was born on a farm in Yolo County in 1948. I went to college majoring in Wildlife Management. Over the years I have known many cattle ranchers in various parts of California. In my opinion the wolf pack in Sierra Valley should be relocated or removed. From what little information I have been able to find the intensive, hardworking efforts of the CDFW personnel to haze the wolves including the use of drones has not been adequate to bring depredation numbers down to acceptable levels. I realize this is not an easy nor quick solution. If you are successful, a suggestion might be to contact members of the Yurok Tribe. They seem to be a serious, progressive pro nature group interested in the complete diverse ecosystem native to their lands.

The Gray Wolf is an intelligent, adaptable predator that can pass behavior to it's offspring, and hunts cooperatively in groups. They are a formidable, apex predator. While many people see nature as peaceful and serene, in reality it is an ongoing battle for survival. The wolves in Yellowstone National Park have an average life expectancy of 3 1/2 to 4 years. They live a hard life. Few, if any, animals die of old age in nature.

In my opinion the practice of allowing wolves to travel wherever they want and settling wherever they want will not be successful, at least here in California. Forty million citizens with all of their vehicles will make it difficult for the wolves to adapt, especially with all of the resulting human-wolf conflicts. I hope the current program of wildlife overpasses, underpasses, and fencing is successful and continues into the future. There are hopefully some areas of California where wolves can live with a minimum of human conflict, but it will require intensive management. And of course working closely with the United States Fish and Wildlife Service, Endangered Species Act regulations, especially section 10(j).

Hopefully what I term Active Hazing will be allowed in the near future. This would allow the humane use of vehicles, drones, non-lethal rounds (not intensionally hitting the animal, but in its general location, a noisy projectile coming in the direction of the animal and hitting the ground stirring up dust or moving vegetation.) Possibly a system of training on proper hazing methods resulting in a certificate might increase the trust

between CDFW and Ranchers. Also maybe voluntary workshops in Ecology and/or Predator Behavior might be helpful.

Unfortunately, a wolf pack with several members and now pups utilizing the Sierra Valley for a home is not working. The cattle ranchers did not agree to the presence of wolves in their area. In my opinion there is not adequate natural prey animals to support a wolf pack. The area is already supporting an increased Black Bear population and there seems to be more Mountain Lions. Bears are driving Lions off of their kills resulting in the Lions killing additional prey animals.

In our general Plumas County area we have endured several substantial wildfires in the last 10 years, plus the Covid Pandemic, plus the on going inflation, and now this wolf situation is resulting in our population experiencing extra stress. The reimbursement program helps. The raising of cattle is a business, the livelihood of the entire ranching family, additionally emotions are normally a factor.

I do not believe this situation is fair to the ranchers or their cattle. It is also not fair to the wolves. I always expected the wolf packs to follow the elk herds west through southern Oregon to the coast, then south into the National and State Parks with larger prey populations. But the wolves obviously had different ideas.

The re-introduction of wolves into Yellowstone National Park was well researched before bringing in the wolves. The prey population was large enough to support the incoming wolf population. Park visitors were receptive to the re-introduction idea. The wolves have been a huge draw for park visitors and have brought an increased income for the Park. It appears the wolves presence has been a positive influence on the overall habitat.

My contact information is Jim Magill, [redacted] Cromberg, CA [redacted] texts can be received at this number; email: [redacted]

Thank you very much for your time.

Sincerely,

James W. Magill

cc. by email to other CDFW employees affected by this situation.

Outlook

NON LETHAL PROTECTION OFSOUTH SHORE BEARS

From djinkens@charter.net <djinkens@charter.net>
Date Tue 09/16/2025 03:15 PM
To FGC <FGC@fgc.ca.gov>

Good Afternoon:

Please see the attached and thank you for your service. I appreciate the work done bCommission members.

David

David Jinkens, MPA
City Council Member
South Lake Tahoe, CA
Retired City Manager

P.O. Box 8066 **South Lake Tahoe, California 96158**

September 15, 2025

Director Charlton H. Bonham
California Department of Fish and Wildlife
P.O. Box 944209
Sacramento, CA 94244-2090

Re: **NONLETHAL SOLUTION TO PROPOSED KILLING OF A MOTHER BEAR IN THE SOUTH SHORE OF LAKE TAHOE**

Dear Director Bonham:

Thank you for your service to our State and for your stewardship of California's wildlife.

I am writing to respectfully request your intervention regarding the proposed lethal removal of a mother bear, known locally as Hope, and the capture of her cub, Bounce, in the South Lake Tahoe region. This proposal has sparked deep concern across our community, especially given the Bear League's generous offer to fully fund the relocation of both bears to a forested area within the Tahoe Basin.

This solution benefits both the Department and local residents. It addresses public safety concerns while honoring our region's values of coexistence and environmental stewardship. Although Hope has entered unsecured and unoccupied homes, no one has been harmed. Often, these incidents stem from mismanaged waste containers, which the city and its waste provider are addressing. The root cause lies in human negligence, not bear aggression.

Until recently, I understood that the Department was pursuing this nonlethal path. It has come to my attention that, if accurate, authorization for lethal action may now be permitted. This change is genuinely concerning because it goes against our community's values, which encourage people and nature to live together peacefully.

I am grateful that Department officials are set to deliver a presentation to the South Lake Tahoe City Council on October 21, 2025. In the meantime, I urge you to direct your staff to suspend any lethal action and allow space for a humane, community-supported resolution.

Please let me know how I can assist in facilitating this outcome. I am available by mail, phone or email as listed below and above.

With respect and urgency,
ORIGINAL SIGNED BY

David Jinkens
City Council Member
(Retired South Lake Tahoe City Manager)
MPA (UCLA), A.B. (U.C. Berkeley)
djinkens@charter.net
530.545.1218 (Phone and text)

Opinions expressed here are mine alone.

C: Interested parties.

Outlook

Mountain Lion Report

From Frank Young <[redacted]>
Date Fri 09/19/2025 12:11 PM
To FGC <FGC@fgc.ca.gov>

I am requesting that the Commission compel CDFW to present the final determination report on Mountain Lion Endangered status, or in lieu of no report supporting the petition request, summarily reject the Petition. Pursuant to Section 2074.6 of the Fish and Game Code, this report was due no later than April 16, 2021
Thank You.

Outlook

CESA mountain lion listing

From Brian Watanabe <[redacted]>
Date Sat 09/20/2025 09:18 AM
To FGC <FGC@fgc.ca.gov>

A publication was supposed to be given within one year of this notice written on April 21, 2020 that is four years overdue. Please publish the findings and submit a written report pursuant to section 2074.6 of the Fishing game code. There Many mountain lion encounters and many of them, threatening or dangerous to human populations. The mountain lions are getting bolder and not fearing humans and their populations are booming. It's past time we have the data. Bring this up-to-date with concurrent information. The number of mountain lines is exceeding what is good for this state and a land!

Brian watanabe
[redacted]

CALIFORNIA FISH AND GAME COMMISSION
NOTICE OF FINDINGS

Mountain Lion
(*Puma concolor*)

NOTICE IS HEREBY GIVEN that, pursuant to the provisions of Section 2074.2 of the Fish and Game Code, the California Fish and Game Commission (Commission), at its April 15-16, 2020 teleconference meeting, accepted for consideration the petition submitted to list an evolutionarily significant unit (ESU) of mountain lions (*Puma concolor)* in southern and central coastal California as threatened or endangered under the California Endangered Species Act.

Pursuant to subdivision (e)(2) of Section 2074.2 of the Fish and Game Code, the Commission determined that the amount of information contained in the petition, when considered in light of the California Department of Fish and Wildlife's (Department) written evaluation report, the comments received, and the remainder of the administrative record, would lead a reasonable person to conclude there is a substantial possibility the requested listing could occur.

Based on that finding and the acceptance of the petition, the Commission is also providing notice that the Southern California/Central Coast ESU of mountain lions is a candidate species as defined by Section 2068 of the Fish and Game Code.

Within one year of the date of publication of this notice of findings, the Department shall submit a written report, pursuant to Section 2074.6 of the Fish and Game Code, indicating whether the petitioned action is warranted. Copies of the petition, as well as minutes of the April 15-16, 2020 Commission meeting, are on file and available for public review from Melissa Miller-Henson, Executive Director, California Fish and Game Commission, 1416 Ninth Street, Suite 1320, Sacramento, California 95814, phone (916) 653-4899.

Written comments or data related to the petitioned action should be directed to the Department contact via email (Esther.Burkett@wildlife.ca.gov); include "Mountain Lion ESU" in the subject line. Comments may also be submitted by mail, addressed to: California Department of Fish and Wildlife, Wildlife Branch, Attn: Esther Burkett/Mountain Lion ESU, P.O. Box 944209, Sacramento, CA 94244-2090. Submission of information via email is preferred.

April 21, 2020

Fish and Game Commission

Melissa Miller-Henson
Executive Director

Outlook

CESA petition

From Wes Davini <[redacted]>
Date Sun 09/21/2025 07:12 PM
To FGC <FGC@fgc.ca.gov>

Hi,

I am requesting that the Commission compel CDFW to present the final determination report on Mtn Lion Endangered status, or in lieu of no report supporting the petition request, summarily reject the Petition. Pursuant to Section 2074.6 of the Fish and Game Code, this report was due no later than April 16, 2021.

Please see image below.

CALIFORNIA FISH AND GAME COMMISSION
NOTICE OF FINDINGS

Mountain Lion
(*Puma concolor*)

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April 21, 2020

Fish and Game Commission

Melissa Miller-Henson
Executive Director

Thanks,
Weston Davini
Sent from my iPhone

Outlook

The WJTC "Plan" is Taxpayer Funded Greenwashing provided as a service to the Solar Industry

From Ashley Gerber <[redacted]>
Date Sun 09/21/2025 07:29 PM
To Wildlife Western Joshua Tree <wjt@wildlife.ca.gov>; FGC <FGC@fgc.ca.gov>

Feedback on the Western Joshua Tree Conservation "Plan"

Summary
The Plan fails to protect Joshua Tree forests and prioritizes industry over real conservation.

1. Major Flaws
The WJTCA is a fee-based system with no authority to stop destruction. It offers bulk discounts to developers, encouraging clear-cutting, while homeowners face strict permit hurdles. Modeled after an Emergency Order that bypassed protections, the plan sets a dangerous precedent.

2. Loss of Trust
CESA once protected Joshua Trees; the Emergency Order undermined that. Forests continue to be bulldozed, eroding trust in endangered species protections. Industry voices were heard—homeowners weren't.

3. The Plan "Solutions" are proven to not work.
Transplanting fails—64% of trees die or suffer. Replanting doesn't work—80% seedling mortality in Cima Dome. The only proven method is preserving existing forests.

4. Better Alternatives Exist
Arizona treats Saguaro Cacti as protected—with felony penalties for removal, but still allows reasonable homeowner exemptions. California should adopt a similar model.

Conclusion
The Plan is simply taxpayer funded Greenwashing provided as a service to the Solar Industry. A true conservation "Plan" must include enforceable protections, fairness, and science—not just fees.

Sent from my iPhone