

STAFF SUMMARY FOR DECEMBER 7-8, 2016

16. MARINE REGULATION PETITIONS AND NON- REGULATORY REQUESTS**Today's Item**Information Action

This is a standing agenda item for FGC to act on regulation petitions and non-regulatory requests from the public that are marine in nature. For this meeting:

- (A) Action on petitions for regulation change received at the Oct 2016 meeting.
- (B) Action on non-regulatory requests received at the Oct 2016 meeting.
- (C) Update on pending regulation petitions and non-regulatory requests referred to staff or DFW for review.

Summary of Previous/Future Actions**(A-B)**

- FGC receipt of new petitions and requests Oct 19-20, 2016; Eureka
- **Today FGC action on petitions and requests Dec 7-8, 2016; San Diego**

(C)

- **Today update and possible action on referrals Dec 7-8, 2016; San Diego**

Background

FGC provides direction regarding requests from the public received by mail and email and during public forum at the previous FGC meeting. Public petitions for regulatory change or requests for non-regulatory action follow a two-meeting cycle to ensure proper review and consideration.

Petitions for regulation change or requests for non-regulatory action scheduled for consideration today were received at the Oct 2016 meeting in three ways: (1) submitted by the comment deadline and published as tables in the meeting binder; (2) submitted by the late comment deadline and delivered at the meeting; or (3) received during public forum.

The public request logs provided in exhibits A1 and B1 capture the regulatory and non-regulatory requests received at the last meeting that are scheduled for FGC action today. The exhibits contain staff recommendations for each request.

- (A) Petitions for regulation change: As of Oct 1, 2015 any "request for FGC to adopt, amend, or repeal a regulation" is required to be submitted on form "FGC 1, Petition to the California Fish and Game Commission for Regulation Change" (Section 662, Title 14). Petitions received at the previous meeting are scheduled for consideration at the next business meeting, unless the petition is rejected under 10-day staff review as prescribed in subsection 662(b).

Today, one marine petition for regulation change received in Oct 2016 is scheduled for action (see summary table Exhibit A1 and individual petition in Exhibit A2).

- (B) Non-regulatory requests: Requests for non-regulatory action received at the previous meeting are scheduled for consideration today.

Today, four non-regulatory requests received in Oct 2016 are scheduled for action (see summary table Exhibit B1 and individual request in Exhibit B2).

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- (C) Pending regulation petitions and non-regulatory requests: This item is an opportunity for staff to provide an evaluation and recommendation on items previously referred by FGC to DFW or FGC staff for review. FGC may act on any staff recommendations made today.

Today, there are updates and recommendations for one pending regulation petition and one non-regulatory request previously referred for review:

Petition #2016-005 (lobster trap placement): Change in the placement of lobster traps and similar devices within the Port of Hueneme. In Jun 2016, FGC referred this petition to DFW for evaluation and recommendation. DFW completed its review and recommends scheduling this for consideration within the lobster rulemaking scheduled for 2017.

Non-regulatory request: In 2015, Martin Strain of Point Reyes Oyster Company requested to amend state water bottom lease Nos. M-430-13, M-430-14, and M-430-17 to add various algal species to its authorized species list. The request was scheduled for FGC action in Apr 2016 however, based on public comment, at the meeting DFW requested additional time to further evaluate the request. DFW completed their evaluation in Sep 2016 and notified the lessee that review pursuant to CEQA would be required and that the lessee would be responsible for completion and cost of the environment document. On Sep 28, the lessee withdrew the request to amend the state water bottom leases citing infeasibility of bearing CEQA costs. No further FGC action is required at this time.

Significant Public Comments (N/A)

Recommendation

- (A-B) Adopt staff recommendations for regulation petitions and non-regulatory requests, as listed in exhibits A1 and B1, to (1) deny, (2) grant, or (3) refer to committee, DFW staff, or FGC staff for further evaluation or information gathering. See exhibits A1 and B1 for staff recommendations for each regulation petition and request.
- (C) Approve DFW recommendation to grant regulation petition #2016-005.

Exhibits

- A1. [FGC table of marine requests for regulation change received by Oct 20, 2016](#)
- A2. [Petition #2016-020 from Dr. Michael Domeier concerning recreational shark methods of take, received Oct 5, 2016](#)
- B1. [FGC table of marine requests for non-regulatory change received by Oct 20, 2016](#)
- B2. [Email from Bill James requesting ADA accommodation for deeper nearshore permits, received Nov 14, 2016](#)
- C1. [Petition #2016-005 from John Demers concerning placement of traps in the Port of Hueneme, received Apr 8, 2016](#)
- C2. [Email from Martin Strain concerning amendment of state water bottom leases, received Sep 28, 2016](#)

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Motion/Direction

Moved by _____ and seconded by _____ that the Commission adopts the staff recommendations for actions on October 2016 regulation petitions and non-regulatory requests and grants Petition #2016-005 for consideration in the lobster rulemaking scheduled for 2017.

OR

Moved by _____ and seconded by _____ that the Commission adopts the staff recommendations for actions on October 2016 regulation petitions and non-regulatory requests and grants Petition #2016-005 for consideration in the lobster rulemaking scheduled for 2017, except for item(s) _____ for which the action is _____, .

CALIFORNIA FISH AND GAME COMMISSION
DECISION LIST FOR REGULATORY ACTION THROUGH OCT 20, 2016
 Revised 11-18-2016

FGC - California Fish and Game Commission DFW - California Department of Fish and Wildlife WRC - Wildlife Resources Committee MRC - Marine Resources Committee

Grant: FGC is <i>willing to consider</i> the petition through a process Deny: FGC is <i>not willing to consider</i> the petition Refer: FGC <i>needs more information</i> before deciding whether to grant or deny the petition  Green cells: Referrals to DFW for more information  Blue cells: Referrals to FGC staff or committee for more information  Lavender cells: Accepted and moved to a rulemaking  Yellow cells: Current action items										
Tracking No.	Date Received	Response Due (10 work days)	Response letter to Petitioner	Accept or Reject	Name of Petitioner	Subject of Request	Code or Title 14 Section Number	Short Description	Staff Recommendation	FGC Decision
2016-020	10/5/2016 (revised and resubmitted from original 8/29/2016 version)	10/19/2016	10/10/2016	A	Dr. Michael Domeier	Recreational shark fishing methods of take	28.95, T14	Disallow bow and arrow and harpoon as legal gear types for recreational take of sharks and rays.	<i>REFER to DFW for evaluation and recommendation.</i>	RECEIPT: 10/19-20/16 ACTION: Scheduled 12/7-8/16



2016-020 Revised

Tracking Number: (~~click here to enter text.~~)

To request a change to regulations under the authority of the California Fish and Game Commission (Commission), you are required to submit this completed form to: California Fish and Game Commission, 1416 Ninth Street, Suite 1320, Sacramento, CA 95814 or via email to FGC@fgc.ca.gov. Note: This form is not intended for listing petitions for threatened or endangered species (see Section 670.1 of Title 14).

Incomplete forms will not be accepted. A petition is incomplete if it is not submitted on this form or fails to contain necessary information in each of the required categories listed on this form (Section I). A petition will be rejected if it does not pertain to issues under the Commission's authority. A petition may be denied if any petition requesting a functionally equivalent regulation change was considered within the previous 12 months and no information or data is being submitted beyond what was previously submitted. If you need help with this form, please contact Commission staff at (916) 653-4899 or FGC@fgc.ca.gov.

SECTION I: Required Information.

Please be succinct. Responses for Section I should not exceed five pages

1. Person or organization requesting the change (Required)

Name of primary contact person: Michael L. Domeier, Ph.D.

Address:

Telephone number:

Email address:

2. Rulemaking Authority (Required) - Reference to the statutory or constitutional authority of the Commission to take the action requested: Title 14; Division 1; Subdivision 1; Chapter 4; Article 1; Sections 200, 202, 205, 219 and 220, Fish and Game Code

3. Overview (Required) - Summarize the proposed changes to regulations: Disallow bow and arrow and harpoon as legal gear types for the recreational take of sharks and rays

4. Rationale (Required) - Describe the problem and the reason for the proposed change: It is important to manage fish and game resources wisely and ethically. Laws are put in place to protect the wild populations of fish and game while allowing for a sustainable level of harvest. Some laws are put in place for ethical reasons, to provide the wild fish and game a minimal level of "fairness." For example, hunters are not allowed to attract and kill game by baiting. Deer, bear, and waterfowl are all good examples of game that could be easily and unethically killed if hunters were allowed to attract them with bait. In some cases methods of hunting or fishing develop that are outside the scope of what resource managers considered when implementing the laws that regulate the sport. Bowhunting for sharks is a method of killing sharks that has recently gained some popularity, and one that has fallen into the grey area between fishing and hunting, where current laws do not adequately protect the sharks. Bowhunting for sharks consists of attracting sharks to the hunting boat and then shooting them in the head with an arrow at very close range. This practice should be banned for many reasons. First, it is a form of hunting, not fishing, and baiting is considered unethical and illegal in the realm of hunting. Second, sharks are slow growing species with very low reproductive rates. Shark bowhunting targets the very largest sharks and therefore is killing off the mature, breeding portion of the population. If this method of killing sharks were to become popular it would be an unsustainable method of harvesting sharks. And



finally, large sharks often have body burdens of heavy metals and toxins that are far above what has been deemed to be safe for human consumption, making them inedible. If the sharks can't be eaten they should not be killed. Furthermore, catch-and-release is not an option when this method of take is used. The number of people targeting sharks with bow and arrow are currently few. Banning the practice now, before it becomes more popular, would impact a very small percentage of the hunting and fishing community.

SECTION II: Optional Information

5. **Date of Petition: 25 August 2016**

6. **Category of Proposed Change**

- Sport Fishing
- Commercial Fishing
- Hunting
- Other, please specify: [Click here to enter text.](#)

7. **The proposal is to:** *(To determine section number(s), see current year regulation booklet or <https://govt.westlaw.com/calregs>)*

- Amend Title 14 Section(s):28.95
- Add New Title 14 Section(s): [Click here to enter text.](#)
- Repeal Title 14 Section(s): [Click here to enter text.](#)

8. **If the proposal is related to a previously submitted petition that was rejected, specify the tracking number of the previously submitted petition** [Click here to enter text.](#)

Or Not applicable.

9. **Effective date:** If applicable, identify the desired effective date of the regulation.
If the proposed change requires immediate implementation, explain the nature of the emergency: 1 January 2017

10. **Supporting documentation:** Identify and attach to the petition any information supporting the proposal including data, reports and other documents: I have attached research papers that document the very high body burdens of toxins in sharks and rays.

11. **Economic or Fiscal Impacts:** Identify any known impacts of the proposed regulation change on revenues to the California Department of Fish and Wildlife, individuals, businesses, jobs, other state agencies, local agencies, schools, or housing: The number of participants in the recreational bow and arrow and harpoon fisheries is very small, so this proposed rule change would have very little economic impact

12. **Forms:** If applicable, list any forms to be created, amended or repealed:

[Click here to enter text.](#)

SECTION 3: FGC Staff Only



Date received: [Click here to enter text.](#)

FGC staff action:

- Accept - complete
- Reject - incomplete
- Reject - outside scope of FGC authority

Tracking Number

Date petitioner was notified of receipt of petition and pending action: 10/10/2016

Meeting date for FGC consideration: December 7-8, 2016

FGC action:

- Denied by FGC
- Denied - same as petition _____
- Granted for consideration of regulation change

Tracking Number

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Quantification of Maternal Offloading of Organic Contaminants in Elasmobranchs Using the Histotrophic Round Stingray (*Urobatis halleri*) as a Model

Article // Environmental Science & Technology · September 2013

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Quantification of Maternal Offloading of Organic Contaminants in Elasmobranchs Using the Histotrophic Round Stingray (*Urobatis halleri*) as a Model

Kady Lyons* and Christopher G. Lowe

California State University, Long Beach 1250 Bellflower Boulevard, Long Beach, California 90840, United States

S Supporting Information

ABSTRACT: Maternal offloading is one route by which young animals may accumulate persistent organic pollutants, such as dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs), but has not been well documented in elasmobranchs despite their propensity to accumulate high concentrations of contaminants. Using the round stingray (*Urobatis halleri*) as a coastal elasmobranch model, we examined maternal offloading processes at two stages in the stingray's entire reproductive cycle. Post-ovulated and near-term pregnant female stingrays were sampled from southern California, and organic contaminants were measured in the ova and embryonic tissues and compared to concentrations measured in corresponding female livers to determine route and extent of transfer. Total organic contaminant loads measured in ovulated eggs were about two times lower than loads measured in embryos ($p < 0.001$) indicating mothers have the ability to transfer contaminants throughout pregnancy. Contaminant loads measured in pups showed a positive relationship with mother's contaminant concentrations ($p < 0.001$); however, mothers offloaded relatively low percentages ($1.5 \pm 1.7\%$) of their total contaminant load using contaminants measured in the liver as a proxy. However, histotrophy is only one form of supplemental provisioning utilized by elasmobranchs and variation in reproductive modes likely influences the extent to which female elasmobranchs may maternally offload contaminants.



■ INTRODUCTION

Polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) and its metabolic and environmental breakdown products (DDE and DDD) are particularly problematic contaminants because they are lipophilic, resistant to biodegradation, and biomagnify in the fatty tissues of upper trophic level predators.¹ Besides acquiring contaminants from dietary exposure,² some species show differences in contaminant concentrations between age and sex classes, indicating that contaminant accumulation can also be influenced by reproduction. Females, unlike males, have the ability to offload contaminants to their offspring, since they provide a direct energetic contribution to nourish developing young.³ Although mammalian females have been documented to offload contaminants by two pathways, placental transfer during gestation and lactation,^{4,5} a majority of contaminants are transferred to young via lactation. During lactation, organochlorines passively follow lipids that are mobilized from blubber to produce lipid-rich milk, which is subsequently consumed by nursing young.^{6,7} Since females transfer a substantial portion of their lipid reserves during lactation, organochlorines are transferred to offspring at a greater rate than during gestation.⁴

Elasmobranchs are another group of animals that invest substantial resources into producing well-developed, precocial young and have the potential to offload contaminants to their young as well.⁸ Elasmobranchs have an equivalent energy storage organ to blubber (i.e., large lipid-rich livers) where

energy is derived to provision young and is the major site where contaminants can accumulate to high concentrations.^{9,10} During egg yolk formation, females transfer hepatic lipids to maturing oocytes via a lipoglycophosphoprotein called vitellogenin.¹¹ Accumulated contaminants are expected to passively follow hepatic lipids as they are mobilized and redistributed in a process similar to milk formation in marine mammals. In addition to large yolk-filled eggs, many viviparous elasmobranchs provide additional nutrition to embryos in the form of yolk-sac-placental conveyance, oophagy (ovulation of additional unfertilized ova consumed by embryos *in utero*), uterine secretions (histotroph), and/or intrauterine cannibalism.⁸ These supplemental provisioning strategies may represent alternative pathways by which contaminants can be transferred to offspring throughout gestation and influence the extent of maternal offloading across reproductive modes in elasmobranchs.

Due to their high trophic positioning, many marine mammals bioaccumulate considerable contaminant loads. Since they serve as a comparable model for humans most research on maternal transfer of contaminants to offspring has focused on marine mammals. Until recently, studies on maternal offloading

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processes in elasmobranchs have been greatly lacking.¹² The low reproductive output of many elasmobranchs and difficulty in obtaining samples have limited the number of in-depth studies examining maternal offloading process using mother-pup pairs.

The round stingray (*Urobatis halleri*) is an abundant species that forages in close proximity to heavily contaminated sediments in southern California¹³ and may represent a suitable model for investigating maternal offloading processes in detail. Round stingrays have one of the shortest gestational periods (approximately 3–4 months) of any elasmobranchs. Since embryos deplete their yolk sacs after the first month of development, mothers provide embryos with supplemental nutrition in the form of histotroph, which nourishes developing young for several months until parturition.¹⁴ Therefore, females have the ability to transfer contaminants to offspring via two routes: ovulated eggs and histotroph. Using the round stingray as an elasmobranch model for species with both a lecithotrophic and histotrophic gestational phase, the objectives of our study were to (1) identify pathways of contaminant transfer from mothers to offspring; (2) determine how factors such as maternal age, contaminant concentration, and fecundity influence the amount females offload; and (3) quantify and compare the proportions of three organic contaminant groups (PCBs, chlordanes, DDTs) transferred from mothers to embryos. Examining maternal offloading processes in detail in a species such as the round stingray may allow us to gain insights and make inferences about similar processes occurring in other, more difficult to study elasmobranchs.

■ EXPERIMENTAL SECTION

Sample Collection. Stingrays were collected in the summer and fall of 2010 and 2011 corresponding to the events of the stingray's reproductive cycle^{14,15} at Seal Beach, Colorado Lagoon, and the Seal Beach National Wildlife Refuge, California (Figure S1). Preovulatory ($n = 18$) and ovulated females ($n = 17$) were collected near the size of maturity (15.7–17.6 and 14–17.7 cm disk width [DW], respectively). Pregnant females were also collected based on disk width to obtain a wide age range of mothers (16.0–33.0 cm DW, $n = 69$). Pregnant females were visually selected based on the degree of abdominal distension,¹⁶ and mid- to late-pregnancy females were sampled.

Animals were collected using a large (26 m long \times 3 m tall and a 2 m cod end, mesh size 5 and 1.5 cm) or a small (15.2 m long \times 1.8 m tall by 0.32 cm mesh) beach seine net. Upon capture, stingrays were sexed, measured (DW, nearest 0.1 cm), and gestation stage was visually assessed for pregnant females. Stingrays were transported back to California State University, Long Beach, (CSULB) where dissections took place. Stingrays were euthanized by immersion in a seawater ice slurry for 30 min followed by spinal pitling, in accordance with approved CSULB IACUC Protocol # 273. Once rays were euthanized, total body and liver weight were obtained and a piece of the left liver lobe was sampled. Preovulatory ova (herein "ova", no. females $n = 18$) and ovulated eggs (herein "eggs", no. females $n = 17$) were dissected from the ovary or uterine horns and weighed to the nearest 0.01 g. Embryos were dissected from pregnant females and sex, disk width, and total body, digestive tract (stomach, spiral valve, spleen, and pancreas), and liver weights (0.01 g) were obtained. Embryos were analyzed as litters by pooling and homogenizing the digestive tract and liver from littermates (no. litters = 69); a pilot study previously

demonstrated negligible amounts of contaminants in non-visceral tissues (Figure S2). Therefore, all subsequent results for contaminants measured in embryos herein refer to those derived from embryonic visceral tissues (i.e., liver and digestive tract). However, embryos near parturition size from one litter were analyzed as whole individuals to test our assumption that contaminants are distributed equally among littermates. All tissues used for organic contaminant (OC) analysis were subsequently wrapped in foil and stored at -20 °C until chemical analyses could take place.

Chemical Analyses. Tissue extractions and contaminant quantifications were performed at CSULB's Institute for Integrated Research on Materials, Environment and Society. Each sample extract was analyzed for DDT and its derivatives ($n = 6$), chlordanes (oxychlordanes, gamma-, alpha-, trans-, cis-chlordane), and 54 congeners of PCBs and summed to obtain total DDT ("DDTs"), chlordanes ("CHLs"), and PCBs.

Following previously described methods,¹⁸ homogenized ova and embryonic tissues and subsamples of female livers were extracted for 14–16 h via a Soxhlet apparatus in 100% methylene chloride (DCM). Prior to extraction, all samples were spiked with a known quantity of recovery surrogates (TCMX, PCB 30, 112, and 198) to measure efficiency of preparative and analytical procedures (target recovery of 70–130%). Sodium sulfate was added to embryo samples due to their relatively high water content. After extraction, samples were concentrated by rotovap and lipid content was determined gravimetrically from split aliquots. Extracts were then purified through elution through an Alumina-B/Silica gel with hexane, 30% DCM in *n*-hexane, and DCM and concentrated. Due to small sample weights, ova extracts were transferred to autosampler vial inserts and concentrated (≤ 100 μ L) to increase detection resolution. All samples were spiked with internal standards (4,4'-dibromobiphenyl and 2,2',5,5'-tetrabromobiphenyl) and injected onto an Agilent gas chromatograph (GC; 6890N series) equipped with a mass selective detector (MSD; Agilent 5973 inert series). The GC column employed was a ZB-5 (Phenomenex; Torrance, California) fused silica capillary (0.25 mm ID \times 60 m) with 0.25 μ m film thickness. The temperature profile of the GC oven was programmed from 45 to 125 °C at 20 °C/min, then to 295 °C at 2.5 °C/min and held for 10 min. Injector and transfer line temperatures were set at 285 and 300 °C, respectively. The source and quadrupole temperatures were set at 230 and 150 °C, respectively. Helium was used as the carrier gas at a flow velocity of 40 cm/s. The MSD was operated in the electron ionization (EI) mode and scanned from 45 to 500 amu at a rate of 1.66 scans/s. Concentrations of organic contaminants were quantified using the software in the GCMS system (Agilent Technologies).

Quality Assurance/Quality Control. Quality assurance quality control samples were run in tandem with each batch ($n = 12$) of study samples to ensure accuracy and precision of data acquired and included one blank, one study sample replicate, two duplicate matrix spikes, and one certified reference material (Lake Michigan Trout tissue 1947, National Institute of Standards and Technology). Matrix spikes were prepared by adding spike surrogates to subsamples used for pesticide and PCB analysis. The QC goal was for 90% of the replicates to yield a relative percent difference (RPD) of $<30\%$ with recovery of spiked analytes at 70–130%.

The mean \pm SD of recovery surrogates was $120 \pm 29\%$, $111 \pm 24\%$, $125 \pm 25\%$, and $84 \pm 23\%$ for TCMX, PCB 30, 112,

and 198, respectively, which demonstrated acceptable efficiency of procedures. Recovery of CRM analytes among batches was $94 \pm 8\%$ for PCBs and $90 \pm 11\%$ for pesticides and blanks showed no signs of procedure contamination. Mean relative significant differences between replicates of sample duplicates and matrix spikes were relatively low ($13 \pm 14\%$ and $8 \pm 9\%$). Mean recovery of matrix spikes was $91 \pm 6\%$ and $82 \pm 10\%$ for PCBs and pesticides. Therefore, QA/QC samples satisfied criteria and data were not corrected for recovery.

Data Analysis. OCs per sample were summed as a whole (herein "summed OCs") and reported as either concentration (wet [ww] or lipid [lw] weight basis) or total load (ng). Total load was calculated by multiplying ww concentration by the total weight of the organ or tissue analyzed. OCs for ova, eggs, and embryos were reported as "standardized total load" (i.e., OCs per number of ova, eggs, or embryos obtained from each female [ng/#]) since tissues were of small enough weight to be analyzed whole. Where percentages were compared, values were arcsin transformed prior to analysis.

Ova and Eggs. Factors that were thought to influence contaminants measured in ova and egg tissues were their weight, females' liver concentration, and female's disk width. Therefore, natural log (LN) transformed values were used in a multiple regression to determine the relationship between these factors and measured contaminant loads in ova and eggs. In addition, the percent of a female's total contaminant load that was transferred to ova or eggs (herein "percent offloaded") was compared by *t* test. A pilot study comparing organic contaminants measured in stingray liver and extra-hepatic tissues (i.e., whole rays excluding liver, $n = 7$) demonstrated that organic contaminant load ($[\text{OC}] \times \text{total tissue weight}$) found in nonliver tissue contributed very little ($3.3 \pm 1.6\%$) to the total body load (Figure S3). Therefore, contaminants measured in livers were used as a proxy for total contaminant load of the animal. The offloading percentages were calculated by the following formula: $(\text{egg or ova load}) / (\text{female total liver load} + \text{egg/ova load}) \times 100$, assuming the contaminant concentrations were homogeneous throughout her liver. Females were expected to have offloaded more contaminants to eggs (fully developed ova) compared to nearly developed (preovulatory) ova found in the ovary.

Eggs and Embryos. Developing embryos typically deplete their yolk reserves by the end of the first or second month at which time females will secrete histotroph to nourish embryos until parturition. Since females provide their young with supplemental nutrition, they have the opportunity to continually offload contaminants throughout pregnancy. To test this hypothesis, we first compared the LN transformed standardized loads offloaded between eggs ($n = 17$) and a subset of near-term embryos ($n = 10$) using Welch's *t* tests from females of comparable disk widths (15.7–17.6 and 16–17.8 cm DW, respectively) so that females were of similar ages. To ensure that any differences found between eggs and embryos were not due to differences in female contaminant loads before reproduction, female loads prior to ovulation were back calculated by adding egg or embryo loads to female total loads and comparing LN transformed values through a *t* test.

In addition to total amount of contaminants offloaded, we were also interested in comparing the types of contaminants that were transferred during different stages of reproduction. The percent of ΣPCBs , ΣDDT , and $\Sigma\text{chloranes}$ measured per sample were compared between eggs and embryonic tissues through a generalized linear model using a beta distribution

with a logit linked function in SAS 9.3. PCBs were further subdivided into groups by number of chlorinated congeners (i.e., tri, tetra, penta, hexa, hepta, octa, nona) and the proportions compared between embryos and eggs. PCB 209 (deca congener group) was removed from analysis due to number of samples where PCB 209 was detected. Proportions were calculated by dividing the sum of each chlorinated congener group by the total amount of PCBs measured per sample.

Mothers and Embryos. Female age (i.e., disk width) and contaminant concentration were hypothesized to influence the amount of contaminants offloaded. In other species, older females have been shown to offload significantly fewer contaminants to their offspring compared to younger females¹⁷ and we expected to see a similar pattern. In addition, the amount of contaminants a female acquires prior to a reproductive event might also play a role in the amount she may transfer to young, where females with higher loads may transfer more to their offspring.¹⁸ We explored these relationships by performing a multiple regression using the unstandardized and standardized total loads measured in a litter against female's disk width, liver concentrations, and total liver load. No relationship was found between their liver lipid content and size ($p = 0.57$) or correlation of contaminant concentration with lipid content ($p = 0.25$); therefore, wet weight concentrations were used. However, female's liver weight did increase with size ($F_{1,67} = 266$, $p < 0.0001$, $R^2 = 0.80$). Normalization of the data to mother's body mass was explored but did not alter the observed patterns; outcomes of this analysis were not included in the results.

Since larger females tend to produce larger litters, we might expect offloaded contaminants to show a "dilution effect" since contaminants can be distributed among more offspring. Therefore, we examined the relationship between standardized LN total litter load and number of embryos per litter through linear regression. In addition, if females offload contaminants continuously throughout gestation we expected the amount of contaminants per litter to increase with increasing disk width of embryos. However, since litter load may be related to their mother's concentrations, we first normalized the standardized litter load to mother's total load.

Lastly, we were interested in the types and proportions of contaminants that females transferred to their offspring. Proportions of offloaded PCBs, chlordanes, and DDTs were calculated by dividing the embryo load of each contaminant group by the summed total load (mother and embryo). Offloaded arcsine transformed proportions were then compared with an ANOVA followed by Tukey's posthoc test. A similar GLM as described above was used, except a repeated measures function was included to account for mother-pup pairs to compare the proportions of PCB congener groups.

RESULTS

Ova and Eggs. Summed OC loads were significantly higher in eggs (132.6 ± 58.2 ng/egg) than in preovulatory ova (71.63 ± 47.7 ng/ova; $t_{33} = 4.22$, $p < 0.001$; Figure 1). Likewise, the percent of offloaded contaminants was approximately twice as high in eggs compared to ova ($0.51 \pm 0.23\%$ versus $0.28 \pm 0.24\%$); however, in the multiple regression of LN summed OC load measured in egg and ova tissues significantly increased with their weight ($F_{3,27} = 23.7$, $p < 0.001$, $R^2 = 0.69$). While summed OC load in ova and eggs increased with weight, the proportion of PCBs and pesticide contaminants measured in

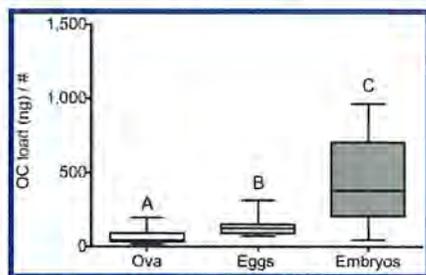


Figure 1. Mean \pm SD of summed organic contaminant (OC) load per litter divided by the number of embryos in each litter (no. of litters = 10) were significantly higher (t test, $p = 0.0006$) than summed OC load measured per egg (no. ovulated females = 17), and OC load per egg was significantly (t test, $p < 0.001$) greater than those per ova (no. preovulatory females = 18). Female stingrays from which these tissues were taken had comparable hepatic OC concentrations ($p = 0.91$). Whiskers represent min and max values and different letters represent significant differences.

these tissues did not change with size increase ($F_{1,33} = 0.68$, $p = 0.41$; Table S1). Although eggs were significantly heavier in weight than ova ($t_{31.5} = 3.47$, $p = 0.002$), the percent lipid content was comparable between these two tissues ($t_{19.8} = -0.03$, $p = 0.97$) and there was no relationship between lipid content and measured contaminants ($F_{1,23} = 0.005$, $p = 0.94$). Furthermore, when compared on a lipid weight basis, ova and egg contaminant concentrations were no longer different with the removal of one ova outlier ($p = 0.2$; Table 1). Of the two female related factors used in the multiple regression, only female's contaminant concentrations ($p = 0.025$) demonstrated a significant relationship with the LN OC load in eggs and ova, and no relationship was found with disk width ($p = 0.9$).

Eggs and Embryos. Mean \pm SD of summed OC loads measured in eggs were significantly lower than those found in embryos from females of comparable sizes (438.66 ± 301.64 ng/embryo; $t_{25} = 3.9$, $p = 0.0006$; Figure 1). Similarly, the mean percent of offloaded contaminants was significantly greater in

late-pregnancy than ovulatory females (1.83 ± 1.58 and $0.52 \pm 0.23\%$; $t_{25} = -4.4$, $p = 0.0002$). While the estimated contaminant load of these females prior to this reproductive event was not different ($p = 0.91$), we did observe a significant decrease in liver lipid content between ovulating and late-pregnancy females ($t_{25} = 2.6$, $p = 0.012$).

Proportions of PCBs, DDTs, and chlordanes were not significantly different between eggs and embryos ($F_{2,67} = 2.36$, $p = 0.10$); however, within these groups proportions by contaminant type differed depending on the number of embryos or eggs sampled per female ($p = 0.008$). As number of embryos or eggs in a "litter" increased, the proportion of PCBs decreased ($p = 0.04$) while the proportion of DDT increased ($p = 0.02$). The mean \pm SD of summed OC load of PCBs (636.9 ± 507.9 and 169.1 ± 77.9 ng, respectively), DDTs (46.38 ± 14 and 37 ± 9.2 ng, respectively), and chlordanes (138.4 ± 139.0 and 31.8 ± 13.0 ng, respectively) were significantly higher in embryos than eggs ($p < 0.001$). When PCB proportions were separated by chlorinated congener group, embryos and ova were found to have significantly different proportions for three out of the seven groups ($p < 0.001$, Figure 2A). Eggs had higher proportions of the most chlorinated congeners (nona $p = 0.003$) and least chlorinated congeners (tri, $p < 0.001$). Deca congeners were only measured in egg tissues. Embryos had higher proportions of the less chlorinated congeners (i.e., tetra and penta, $p = 0.06$ and 0.004). Eggs and embryos were similar in proportion for hexa, hepta, and octa congener groups ($p = 0.9$, 0.7 , and 0.2).

Mothers and Embryos. While the average percent of offloaded contaminants was relatively low ($1.5 \pm 1.7\%$) it was highly variable and showed a decreasing relationship with female size ($F_{1,67} = 6.0$, $p = 0.016$). No relationship was found between average embryo disk width and their mother's liver weight normalized to her disk width ($p = 0.24$). However, the standardized (i.e., per embryo) and unstandardized litter LN contaminant loads showed a positive relationship with their mother's liver contaminant concentration ($F_{3,64} = 10.73$ and

Table 1. Organic Contaminants Measured in the Livers of Pre-Ovulatory and Ovulating Females and Their Ova (Outlier Removed, $n = 17$) and Eggs and Those Found in Embryos and Their Mother's Liver Are Reported as Total Load, Wet Weight Concentration (ww), and Lipid Weight Concentration (lw)^a

sample	total load ($\mu\text{g}/\#$ or μg)	n	% lipid	[ww] ($\mu\text{g}/\text{g}$)	[lw] ($\mu\text{g}/\text{g}$)
Ova	0.07 ± 0.04		5.1 ± 1.9	0.17 ± 0.1	2.9 ± 1.0
Females	27.5 ± 13.9	18	47.8 ± 11	1.4 ± 0.64	3.0 ± 1.4
Eggs	0.13 ± 0.06		9.0 ± 0.59	0.22 ± 0.11	2.5 ± 1.1
Females	43.7 ± 12.3	17	58.0 ± 6.8	1.7 ± 0.5	3.0 ± 1.1
Embryos					
5.0–5.5	0.17 ± 0.14		2.4 ± 3.6	0.21 ± 0.14	8.3 ± 5.6
Mothers	66.9 ± 36.1	12	47.6 ± 8.5	2.4 ± 0.12	4.5 ± 2.2
5.51–6.0	0.32 ± 0.2		2.8 ± 0.85	0.21 ± 0.08	11.6 ± 8.1
Mothers	44.5 ± 7.4	11	44.5 ± 7.4	2.7 ± 0.9	4.7 ± 1.5
6.01–6.5	0.44 ± 0.31		1.8 ± 1.0	0.17 ± 0.09	9.3 ± 7.6
Mothers	132 ± 85	19	45.6 ± 9.0	3.0 ± 1.5	4.8 ± 2.5
6.51–7.0	0.40 ± 0.21		2.5 ± 1.7	0.15 ± 0.07	10 ± 6.2
Mothers	82.9 ± 44.5	12	47.7 ± 11.6	2.6 ± 0.82	3.9 ± 1.3
7.01–7.5	0.80 ± 0.36		3.0 ± 2.4	0.17 ± 0.13	9.6 ± 9.4
Mothers	178 ± 192	7	37.9 ± 20.5	3.9 ± 1.9	5.4 ± 2.6
7.51–8.12	0.68 ± 0.47		1.6 ± 0.7	0.16 ± 0.11	6.3 ± 3.4
Mothers	94.9 ± 53.4	6	48.0 ± 4.3	2.1 ± 0.51	2.7 ± 0.6

^aTotal load represents the product of wet weight (ww) concentration found in the sample multiplied by the weight (g) of tissue analyzed. Ova, eggs, and embryo total loads were standardized to the number sampled from each female or mother (i.e., $\mu\text{g}/\#$).

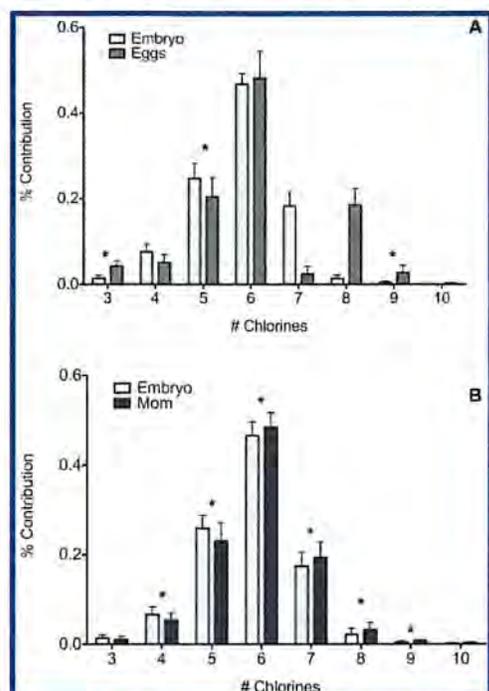


Figure 2. (A) Proportions PCB congener groups in embryos (light gray bars) were similar to those in ovulated eggs (gray bars), except for tri, penta, and nona congener groups. (B) Embryos had significantly higher proportions of tetra and penta PCB congeners compared to their mother's liver (dark gray bars) that had higher proportions of heavier chlorinated PCB congener groups (hexa-nona). Asterisks denote significant differences between embryos and ovulated eggs or mothers.

17.06, $p < 0.0001$, $R^2 = 0.30$ and 0.42 ; Figure 3). Mother's total load was not significant ($p = 0.12$) and size only showed a

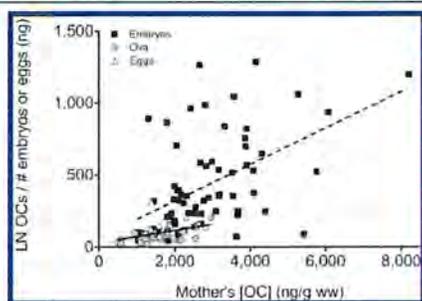


Figure 3. Natural log (LN) of summed OCs (ng) measured per litter per embryo (black triangles) and per ova (gray circles) and egg (gray triangles) showed a significant, positive relationship with increases in their mother's hepatic OC concentration [ww] ($n = 69$, $p < 0.0001$, $R^2 = 0.32$ and $n = 35$, $p = 0.009$, $R^2 = 0.16$, respectively). However, the rate of increase was significantly greater in the embryos (dashed line) than the ova/eggs (solid line; ANCOVA $F_{1,100} = 20.4$, $p < 0.0001$).

positive relationship with litter contaminant loads when they were not standardized per embryo ($p = 0.01$).

While a significant relationship was found between the LN of the total unstandardized litter load and number of embryos in a litter ($F_{1,67} = 5.6$, $p = 0.02$), standardized OC load with respect to litter size was marginally insignificant ($F_{1,67} = 3.5$, $p = 0.06$). Contaminant loads in one litter of near-term embryos (PF-14, n

= 5) were analyzed individually and all embryos except for one, whose lipid levels were lower than his littermates, showed very little difference in contaminant load (1063 ± 117 versus 603 ng summed OCs; Figure S4). Contaminants measured in litters were also influenced by the stage of gestational development. The LN of standardized embryo load, which were normalized by their mother's liver concentration (i.e., ng/embryo/[mother's OC]), increased as the average disk width for the litter increased ($F_{1,67} = 29.0$, $p < 0.0001$, $R^2 = 0.21$). A nonlinear regression of standardized litter load (normalized to their mother's liver concentration) with embryo size showed a similar pattern to that of the relationship between average litter weight and disk width ($R^2 = 0.38$ and 0.93 , respectively; Figure 4). In addition, concentration by lipid weight becomes substantially greater than their mother's as the size class of embryos increased (Table 1).

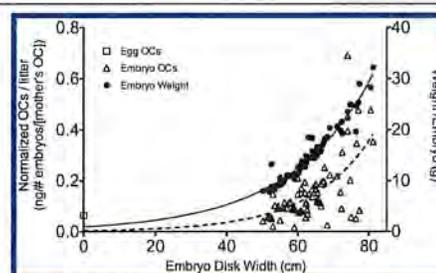


Figure 4. OCs measured per litter per embryo normalized to their mother's liver OC wet weight concentration (open triangles) increased in a nonlinear fashion as the average litter disk width increased (dashed line). In addition, OCs measured in embryos were substantially greater than the average OCs found in eggs (open square). Increases in litter OCs with disk width was similar to the relationship found between average litter weight per embryo and disk width (closed circles, solid line) during the mid to late gestational (no. of litters = 69).

Embryos showed similar contaminant profiles as their mothers in that mean \pm SD load of PCBs comprised a majority of the total contaminant load (1062 ± 1012 ng; $81.4 \pm 6.2\%$) with chlordanes representing the next largest contaminant group (194.0 ± 230.9 ng; $14.3 \pm 6.9\%$) followed by DDT (51.2 ± 48.3 ng; $4.2 \pm 2.2\%$; Table S1). However, the LN of the offloaded proportion of these three contaminant groups was significantly different (ANOVA $F_{2,202} = 7.34$, $p = 0.0008$). DDT was found to be offloaded at a higher proportion ($2.66 \pm 2.68\%$) compared to PCBs and chlordanes ($p = 0.002$ and 0.003 , respectively), while PCBs and chlordanes were comparable ($1.46 \pm 1.6\%$ and $1.63 \pm 2.62\%$; $p = 0.98$; Figure 5). The PCB chlorinated congener groups also showed similar patterns between embryos and mothers, with hexa congeners making up the largest proportion of PCB contaminants when pooled ($47.4 \pm 3.2\%$), followed by penta ($24.4 \pm 3.8\%$), hepta ($18.3 \pm 3.5\%$), tetra ($5.9 \pm 1.8\%$), octa ($2.7 \pm 1.5\%$), tri ($1.3 \pm 0.7\%$), nona ($0.64 \pm 0.42\%$), and deca ($0.2 \pm 0.1\%$) congener groups. However, the relative proportions of each congener group were different between mothers and embryos for all congener groups ($p < 0.009$) except for tri congeners, which were marginally insignificant ($p = 0.051$, Figure 2B). Embryos were found to have higher proportions of tetra and penta congener groups, while mothers had higher proportions of the more chlorinated groups (i.e., hexa-nona).

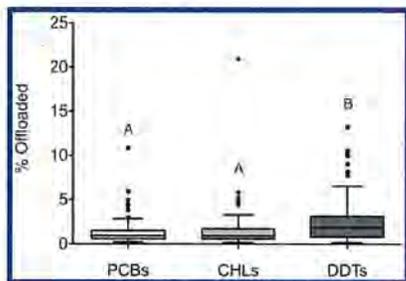


Figure 5. Proportion of offloaded contaminants measured in embryos ($n = 69$) was significantly different ($p = 0.008$) among groups with DDT (dark gray) having higher rates than PCBs (light gray) or chlordanes (gray). Boxes represent the first and third quartile and dark lines indicate group means.

DISCUSSION

Female round stingrays were found to maternally offload contaminants to their offspring via two pathways. One route of transfer was through the production of yolky eggs, which embryos utilized during the first third of the gestation period.¹⁴ During the energetic process of vitellogenesis, females redistribute lipids from their livers to ova.¹¹ Livers are the main energy storage organ in elasmobranchs and thus tend to have the highest contaminant concentrations.^{19,20} Therefore, as hepatic lipids are mobilized and transferred to ova contaminants will passively follow. The positive relationship found between ova weight and contaminant load suggests that females continually transfer contaminants to ova throughout their development until ovulation. Given the comparability of ova and egg concentrations on a lipid weight basis suggests that lipid transfer is the vehicle by which contaminants are transferred to these tissues. In addition, females with higher contaminant concentrations transferred higher loads to eggs and ova. Therefore, female's contaminant concentration seems to be an important factor influencing the total amount of contaminants that can be transferred to offspring. Ovulated eggs had significantly higher contaminant loads compared to near ovulation sized ova. Although the percent lipid content did not differ between the two, the larger weight, and therefore total lipid content of ovulated eggs, likely results in greater transfer of these lipophilic contaminants compared to developing ova, which have not yet reached complete maturation.

The second route by which female round stingrays were shown to offload contaminants was through the production of histotroph, or uterine milk,¹⁴ which embryos consumed as a supplemental form of nutrition for a majority of gestation until parturition. The significantly higher loads of summed OCs and greater offloading percent of near-term embryos compared to ovulated eggs demonstrates that females are able to continually transfer contaminants to offspring during gestation. Females of comparable sizes were chosen to remove any potential age influences, since older females would have more time to accumulate contaminants than younger females, which was important to consider since maternal hepatic contaminant concentrations were found to significantly influence the amount of contaminants females offloaded to both eggs and embryos. Assuming homogeneous liver contaminant concentrations, pre-reproductive loads calculated for ovulated and pregnant females were not significantly different in their total contaminant load. Therefore, the higher loads in embryos compared to eggs is due

to additional transfer during gestation rather than prior differences in female's contaminant load or size.

While the exact lipid content may vary among species, histotroph is rich in lipids²¹ and could result in substantial contaminant transfer. Fatty acids of histotroph measured in two species of rays (butterfly ray, *Gymnura micrura*, and cownose ray, *Rhinoptera bonasus*)²² were found to be very similar in their composition to those measured in human (*Homo sapiens*) and bovine (*Bos taurus*) milk. Unfortunately, we were unable to measure the contaminant concentrations of histotroph due to uterine flushing by females, which would likely result in lower than actual measured loads. However, late pregnancy females had significantly lower concentrations of hepatic lipids than ovulating females. We assume this decrease in lipid results from continued energetic input, and therefore contaminant transfer, to offspring during gestation, which has been documented in other batoid rays.²³ Since round stingrays undergo continual oogenesis and vitellogenesis it is likely these processes will contribute to the decrease in maternal hepatic lipids as well. However, since developing oocytes in sampled females were small in size (~ 0.1 – 0.4 cm diameter), number ($n = 1$ – 3), and still at an early developmental stage¹⁴ (K. Lyons, personal observation) the proportion of lipids directed to oocytes versus embryos is expected to be small.

In addition, standardized embryo contaminant load increased in a similar pattern to embryo growth rate as development progressed. This further supports our hypothesis that females transfer contaminants to offspring during gestation at least for the midlate developmental stages. If embryos did not continually accumulate contaminants during development, contaminant loads would decrease as embryos reached parturition size, which was not observed. Furthermore, embryo lipid weight contaminant concentrations were consistently greater than their mother's liver concentrations, which corresponds to similar observations made in marine mammal systems.^{7,27} This highlights the transfer of organic contaminants via lipids from mothers to embryos and their subsequent concentration in neonatal tissues. This supplemental provisioning by mothers is important not only for continued embryo growth throughout gestation, but also for the accumulation of energy reserves that offspring will depend on postpartum until they can competently feed on their own.²⁴ Indeed, embryos further in development had relatively larger livers compared to the weight of other visceral organs (i.e., stomach and spiral valve) than embryos that were less well developed (K. Lyons, unpublished data).

While standardized loads were higher in embryos, the contaminant proportions of PCBs, DDTs, and chlordanes were comparable between eggs and embryos. Therefore, females probably do not transfer these three contaminant groups at different rates during egg formation or throughout pregnancy. Although total PCB proportion was similar, the composition of PCBs by chlorinated congener group was significantly different between eggs and embryos, indicating differential transfer rate at these two points in reproduction (i.e., vitellogenesis and pregnancy). Less chlorinated PCB congeners tend to be more labile and less lipophilic than heavier, more chlorinated congeners.²⁵ Therefore, the lipophilicity of different PCB congeners will influence their mobility and thus ability to be transferred. Congener groups that had fewer chlorines (tetra and penta) were found in higher proportions in embryos than in eggs. Although very low in proportion and load, the most chlorinated congeners (deca) were only measured in eggs.

Indeed, maternal offloading studies in marine mammals have demonstrated that PCB congeners are transferred at differential rates, with the lighter congeners being transferred more easily.^{26–28} In addition, PCB transfer may also be influenced by their affinity for different types of lipids,²⁹ which may be mobilized at various stages of reproduction.⁷ In the round stingray, the types of lipids used for yolk formation may differ between those utilized for histotroph secretion, which could lead to differences in the proportions of contaminants transferred if lipids vary in their hydrophobicity. Since higher proportions of the more chlorinated congeners were found in eggs compared to embryos, this suggests that more nonpolar lipids may be transferred to eggs than during the histotroph phase of gestation, but this remains to be explored.

Maternal hepatic contaminant concentrations appeared to be the most influential factor accounting for contaminant load offloaded to eggs and embryos, regardless if it was standardized by litter size. We may infer that a maternal condition may play an important role in maternal offloading. If females were in a starved or catabolic state, then contaminants would become more concentrated in hepatic tissues as energy stores were utilized. Alternatively, maternal feeding rate and location may influence their contaminant uptake rate, which could lead to higher concentration if it exceeded liver growth rate. In either scenario, subsequent lipid mobilization for reproduction would lead to greater maternal transfer as the amount of contaminants dissolved in those lipids would be higher. In addition, when mothers' liver OC concentrations were normalized to their disk width and liver weight (i.e., [OC]/liver weight/disk width) and compared to the average embryo disk width of the litter a positive relationship was found such that mothers' normalized OC concentrations significantly increased as embryos increased in size during development.

Using disk width as a proxy, age in this study was found to be significant only when unstandardized embryo litter load was used. The explanatory power of age (i.e., disk width) with respect to maternal offloading in this species maybe complicated by the fact that liver growth rate exhibits a linear relationship with disk width (K. Lyons, unpublished data). A contaminant uptake rate that is more or less equal to growth rate may result in rather stable contaminant concentrations despite growth, uncoupling these two variables.

Regardless, the proportion of females' total contaminant load as estimated by the liver that was transferred to offspring was much lower than expected ($1.5 \pm 1.7\%$). Since mothers are not fasting during pregnancy, their continued acquisition of dietary contaminants may result in an underestimation of the extent of maternal transfer, to a degree. Contrary to expectation, we found that mother's hepatic OC concentrations increased from the mid to late gestational stages despite the lack of change in female liver weight, which suggests that mother's intake of newly acquired contaminants during gestation was greater than the amount they were offloading. Nevertheless, the results of our study are in stark contrast to maternal offloading studies in other species of elasmobranchs such as white (*Carcharodon carcharias*) and thresher (*Alopias vulpinus*) sharks, which suggest that females transfer a substantial portion of their contaminants to offspring.¹² White and thresher sharks utilize oophagy (where embryos consume unfertilized ovulated eggs throughout gestation³⁰), have substantially longer gestational periods, and produce highly developed young.^{31,32} Despite differences in supplemental provisioning, round stingrays also have a substantially shorter gestation period and produce young

comparatively smaller in size, which would greatly limit the opportunity for females to offload contaminants compared to white or thresher sharks. Given that elasmobranchs demonstrate a wide range of reproductive modes from lecithotrophy to pseudoplacental matrotrophy, varying degrees of maternal investment is likely an important factor influencing the magnitude of maternal transfer in elasmobranchs.

While round stingray females were able to offload more contaminants to larger litters, the amount offloaded per pup in each litter was not related to their mother's size (i.e., age) or the number of siblings in a litter. Since fecundity increases with size in round stingrays as it does in many other species of elasmobranchs, we originally expected embryos from larger females to have fewer contaminants due to (1) hypothesized significant decreases in maternal contaminant concentrations after successive reproductive cycles and (2) a dilution effect due increased number of offspring with concurrent increases in maternal size. The weak relationship between female's size (i.e., age) and hepatic contaminant concentration, which was the most influential factor, was likely the reason the amount of contaminants offloaded per embryo remained relatively constant despite larger litters and older ages in larger sized females. If round stingray females were removing a substantial portion of their contaminants through reproduction, we would expect to see contaminant load per embryo per litter decrease, or become diluted, with increase in litter size, since larger, older females are more fecund, which was not the case.

Although mothers and their embryos showed similar contaminant composition patterns for the three contaminant groups with PCBs comprising a majority, the offloading rates of the three contaminant groups were significantly different. While DDTs made up the smallest portion of the total contaminant load, this contaminant group was offloaded in the highest proportion compared to PCBs and chlordanes. Similar offloading patterns have been observed in many marine mammals species where DDTs are transferred at higher proportions than PCBs²⁷ due to differences in chlorination, which is related to lipophilicity. The major metabolite of DDT, 4,4'-DDE, which has 4 chlorines, comprised a majority ($88 \pm 18\%$, $n = 238$) of the DDT-related compounds measured. In addition, a large portion of the PCB congeners detected had 6 or more chlorines ($70 \pm 6\%$, $n = 238$). Therefore, the fewer number of chlorines found on 4,4'-DDE compared to PCBs and chlordanes (8–9 chlorines) could make it more easily transferrable and could account for the higher transfer proportion of DDT compared to the other two groups.

The patterns of PCB congener composition found in female and embryo stingrays were similar to those found in other marine organisms such as bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Mexico²⁶ and ringed seals (*Phoca hispida*) from Canada,³³ highlighting the ubiquity of PCBs despite large geographic separation. However, significant differences between embryos and mothers were found for all PCB congener group proportions, except for tetra congeners. Embryos had higher proportions of tri, tetra, and penta congeners compared to mothers that had higher proportions of the more chlorinated congeners (hexa-deca). These results parallel those found in marine mammal maternal offloading studies.^{5,6,26}

Despite the overall low offloading rate of female round stingrays, the loads measured in embryos were substantial and embryos within a litter appear to receive similar amounts of contaminants. While we did not measure any metrics that

might be indicative of negative physiological effects, populations of stingrays in southern California are quite healthy despite the fact that embryos are exposed to potentially harmful chemicals during development and adult females accumulate contaminant loads comparable to higher trophic level elasmobranchs.^{34–36} Further studies should continue to explore the dynamic between maternal offloading of contaminants and reproductive mode in elasmobranchs as well as the effect of embryonic and neonatal exposure.

■ ASSOCIATED CONTENT

● Supporting Information

Additional data on contaminants and collection sites. This material is available free of charge via the Internet at <http://pubs.acs.org>.

■ AUTHOR INFORMATION

Corresponding Author

*E-mail: kady.lyons@sbcglobal.net. Telephone: 562-985-4918, Fax: 562-985-8878.

Notes

The authors declare no competing financial interest.

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BRIEF COMMUNICATION

Insights into the life history and ecology of a large shortfin mako shark *Isurus oxyrinchus* captured in southern California

K. LYONS*†, A. PRETI‡§, D. J. MADIGAN||, R. J. D. WELLS¶, M. E. BLASIUS*,
O. E. SNODGRASS‡§, D. KACEV**, J. D. HARRIS††, H. DEWAR§, S. KOHIN§,
K. MACKENZIE§§ AND C. G. LOWE*

*California State University Long Beach, Department of Biological Sciences, 1250 Bellflower Blvd, Long Beach, CA 90840, U.S.A., ‡Ocean Associates, Incorporated, 4007 N Abingdon Street, Arlington, VA 22207, U.S.A., §Fisheries Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037, U.S.A., ||School of Marine and Atmospheric Sciences, Stony Brook University, 105 Dana Hall, Stony Brook, NY 11794-5000, U.S.A., ¶Texas A & M University Galveston, Department of Marine Biology, 1001 Texas Clipper Rd, Galveston, TX 775543, U.S.A., **San Diego State University, Biology Department, 5500 Campanile Dr, San Diego, CA 92182, U.S.A., ††National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Seattle, WA, U.S.A. and §§School of Biological Sciences (Zoology), The University of Aberdeen, Tillydrone Avenue, Aberdeen, Scotland AB24 2TZ, U.K.

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In June 2013, a record-breaking female *Isurus oxyrinchus* (total length 373 cm, mass 600 kg) was captured by rod and reel off Huntington Beach, California, where it was subsequently donated to research and provided a rare opportunity to collect the first data for a female *I. oxyrinchus* of this size. Counts of vertebral band pairs estimate the shark to have been *c.* 22 years old, depending upon assumptions of band-pair deposition rates, and the distended uteri and spent ovaries indicated that this shark had recently given birth. The stomach contained a *c.* 4 year-old female California sea lion *Zalophus californianus* that confirmed the high trophic position of this large *I. oxyrinchus*, which was corroborated with the high levels of measured contaminants and tissue isotope analyses.

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Key words: contaminants; foraging ecology; life history; management.

In the northeastern Pacific Ocean (NEP), shortfin mako sharks *Isurus oxyrinchus* (Rafinesque 1810) are prominent, widespread predators that utilize both coastal and oceanic habitats (Compagno, 2001; Block *et al.*, 2011). While considerable data have been collected on immature specimens, little is known about mature animals,

†Author to whom correspondence should be addressed. Tel.: +1 310 961 4405; email: kady.lyons@sbcglobal.net

particularly females. Data collection on large, mature *I. oxyrinchus* females (280 cm total length, L_T ; Joung & Hsu, 2005) is often difficult because these specimens are typically less prevalent, harder to capture, unable to be held in captivity and, unlike the great white shark *Carcharodon carcharias* (L. 1758), they do not form known aggregations. Despite the importance of large females to the reproductive potential of the population (Tsai *et al.*, 2014), very little basic information about mature female *I. oxyrinchus* is available, particularly with regard to morphometrics, reproductive biology, foraging ecology, contaminant loads and age and growth. In the summer of 2013, a 373 cm L_T *I. oxyrinchus* was captured recreationally by hook and line off the coastline of the Southern California Bight (SCB) and subsequently donated to research. The purpose of this paper is to provide insights into aspects of the life history and ecology of *I. oxyrinchus* obtained from this rare specimen.

On 3 June 2013, a female *I. oxyrinchus* was captured by a recreational angler fishing c. 24 km off Huntington Beach, California (33.48° N; 118.15° W). The shark was transported to New Fishall Bait Co. (<https://www.facebook.com/NewFishallBaitCo>) where it was stored chilled (*i.e.* not fully frozen) until necropsy on 9 June 2013. External measurements (straight line and curve lengths) were taken as well as masses of organs at the time of dissection (Tables I and II).

The stomach was cut anteriorly and the fluid inside the stomach was removed, weighed on-site and filtered through a 0.5 mm mesh sieve. The whole stomach and contents were then transported to the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center (SWFSC), La Jolla, CA, for examination. Materials and fluid were rinsed and sorted through a series of screen sieves with mesh sizes of 9.5, 1.4 and 0.5 mm. The stomach was distended and contained the remains of a California sea lion *Zalophus californianus* (CSL; Fig. 1). By using the skull morphology and teeth annuli, it was possible to determine that the CSL was a juvenile female c. 4 years of age (Lowry & Folk, 1990). The mean \pm 95% C.I. mass was estimated at 67.6 ± 17.0 kg based on a linear age growth model constructed from wild female CSLs ($n = 26$) that ranged from 2.00 to 3.41 years of age (National Marine Mammal Laboratory, Seattle, WA).

To investigate long-term feeding ecology, stable-isotope analysis (SIA) on white muscle tissue was performed, which in large sharks provides information on the diet over the past year or more (Carlisle *et al.*, 2012). Dorsal muscle tissue was sampled and frozen at -20° C and prepared for analysis (including urea extraction) following the methods of Madigan *et al.* (2012). $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values from this *I. oxyrinchus* were compared with regional prey and predator values from Carlisle *et al.* (2012) and Madigan *et al.* (2012) to subjectively assess whether this individual appeared to largely reflect feeding in the California Current Large Marine Ecosystem (CCLME).

A Bayesian mixing model MixSir (Moore & Semmens, 2008) was used to estimate the relative importance of prey contributions in the CCLME to the diet of this *I. oxyrinchus*. Trophic groupings from Madigan *et al.* (2012) as well as $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ from selected marine mammals (Carlisle *et al.*, 2012) were used to assess the contributions of marine mammals, large predators, smaller predators and forage fish to the diet of this *I. oxyrinchus*. One million iterations were run where shark and diet–tissue discrimination factors (DTDF: the difference between shark diet $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values) from large active sharks were used [mean \pm s.d. $\Delta^{15}\text{N} = 2.29 \pm 0.22$, $\Delta^{13}\text{C} = 0.90 \pm 0.33$; Hussey *et al.* (2010)]. White muscle $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for this *I. oxyrinchus* were -16.3 and 17.1‰ , respectively (C:N = 3.3). Assuming predation

TABLE I. Various morphometrics of the *Isurus oxyrinchus* taken upon dissection. External measurements were taken over the curve of the body and as a straight line

Measurements	Curve length (cm)	Straight-line length (cm)
Body		
Total stretch	386	383
Total natural	373.5	373
Fork		
Precaudal (to notch)	343	337
Snout to last gill slit	313	310
Snout to dorsal origin	111	101
Snout to vent	144	139
Snout to second dorsal-fin origin	244	227
Snout to second dorsal-fin origin		270
First dorsal-fin origin to second origin	132	130
Snout to anal-fin origin	290	275
Snout to left pectoral-fin origin	100	89
Snout to orbit	25	
Snout to nare	16	
Nare to nare	17.2	
Girths		
Anterior to dorsal origin	238	
Posterior to pectoral-fin insertion	209	
Anterior to pelvic-fin origin	150	
Fins		
Width across keel	32	
Dorsal fin		
Height from midline	35.5	
Height from origin	44	
Origin to free rear tip width	43	
Origin to insertion width	37	
Pectoral fin		
Origin to tip	65	
Widest width	39	
Origin to insertion width	30	
Caudal fin		
Width (origin to fork)	26	
End of keel to fork	23	
Length of superior caudal fin	66	
Length of inferior caudal fin	52	
Height (tip to tip of caudal)	98	
Pelvic fin		
Origin to insertion	22	
Origin to free rear tip	26	
Width of left pelvic fin	10	
Gill slits		
Length of fifth gill slit	35	
Length of fourth gill slit	32	
Length of third gill slit	31	
Jaws		
Midline of upper jaw to left joint	29.8	
Gape (joint to joint)	25	
Eye diameter	4.6	
Reproductive		
Uteri length (R, L)	90, 89	
Uteri width (R, L)	15, 15	
Shell gland length (R, L)	8, 8	
Shell gland width (R, L)	5.3, 5	

R, right; L, left.

TABLE II. Mass of internal organs of *Isurus oxyrinchus* taken at the time of dissection. Total mass of the animal was obtained from an International Game Fish Association (www.igfa.org) certified scale at the time of landing

Organ	Mass (kg)
Total	600.11
Liver	56.70
Left liver lobe	29.03
Right liver lobe	27.67
Reproductive tract (ovaries and uterus)	4.97
Heart	0.73
Pancreas	0.39
Total mass of stomach and contents	95.30
Stomach fluid removed	67

primarily in the CCLME, these values indicate a high trophic level for this *I. oxyrinchus* based on comparison of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values with other CCLME predators (Madigan *et al.*, 2012). $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were higher than those of other pelagic predators (billfish, tunas, jacks and small sharks) in the CCLME (Madigan *et al.*, 2012) but lower than those of marine mammals and *C. carcharias* in the CCLME (Carlisle *et al.*, 2012; Fig. 2). Estimated prey (with ranges) contributions to the *I. oxyrinchus* diet were marine mammals 29% (5–55%), large predators 24% (2–70%), smaller predators 18% (2–56%) and forage fishes and squids 18% (2–47%).



FIG. 1. Remains of the *Zalophus californianus* found in the *Isurus oxyrinchus* stomach. Photo credit: Rocky Kasler

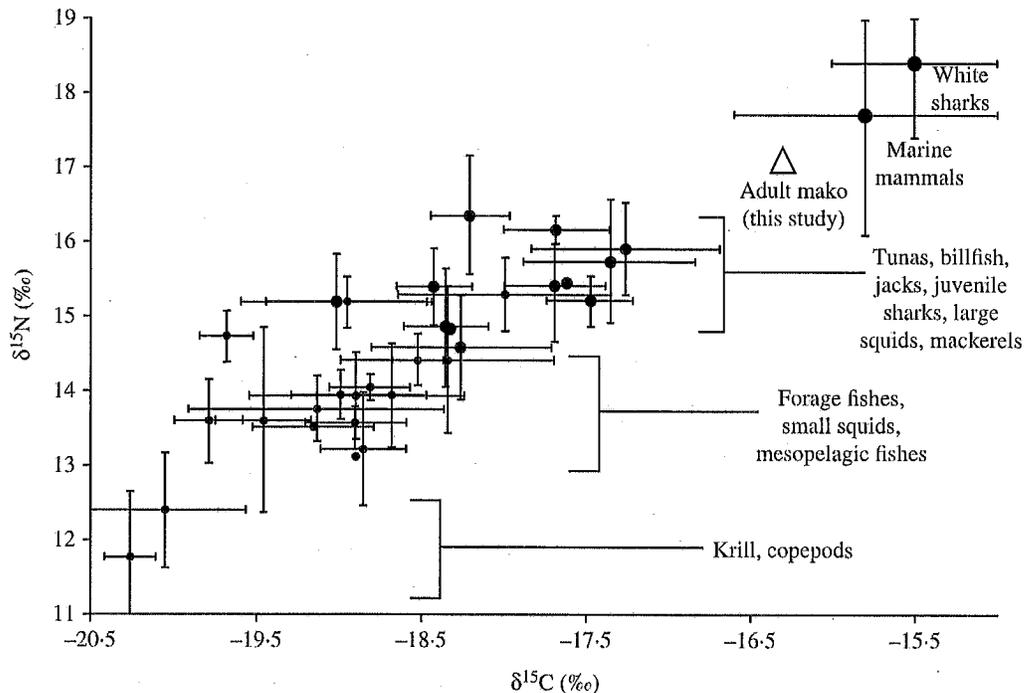


FIG. 2. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values (mean \pm s.d.) for pelagic predators (●) and prey (●) in the California Current Large Marine Ecosystem. The large adult *Isurus oxyrinchus* of this study is represented (Δ). Pelagic predator and prey data from Madigan *et al.* (2012); *Carcharodon carcharias* data from Carlisle *et al.* (2012); marine mammal data are for *Phocoena phocoena* (Toferoff, 2002) and *Mirounga angustirostris*, *Phoca vitulina* and *Zalophus californianus* (Burton & Koch, 1999).

Spiral valve parasites are generally diet related and can also provide information on the diet of a shark over a longer period than the classification of identifiable food items in the gut. The spiral valve was cut open longitudinally along the line of the main blood vessel to reveal the inner lumen. All parasites found were fixed in 10% formalin and sent to the University of Aberdeen, Scotland, U.K., for identification. Three types of helminth parasite were found: 20 specimens of the tetraphyllidean tapeworm *Ceratobothrium xanthocephalum*, two of a trypanorhynch tapeworm of the family Tentaculariidae and some fragments of *Capillaria* spp. nematodes. *Ceratobothrium xanthocephalum* has been previously reported from an *I. oxyrinchus* caught off Montauk, New York (Olson *et al.*, 1999), but this is the first record from *I. oxyrinchus* for the Pacific Coast of North America. Nematodes of the genus *Capillaria* are parasites of teleosts and thus indicate predation on bony fishes.

Vertebral band-pair counts were used to estimate the age of this *I. oxyrinchus*. Vertebral centra were extracted from between the gills and the first dorsal fin and sectioned through the middle along the sagittal plane into bow-tie sections. Two methods were used to identify band pairs in the centra: (1) high frequency x-radiography (Cailliet & Bedford, 1983; Wells *et al.*, 2013) and (2) light microscopy (Bishop *et al.*, 2006; Natanson *et al.*, 2006). Both the x-radiography and light microscopy methods yielded similar counts of 26–28 band pairs (post-birth band), and all readers collectively discussed the images and agreed to a consensus count of 27 band pairs (Fig. 3). The periodicity of band-pair deposition for *I. oxyrinchus* in the NEP up to age 5 years has been validated

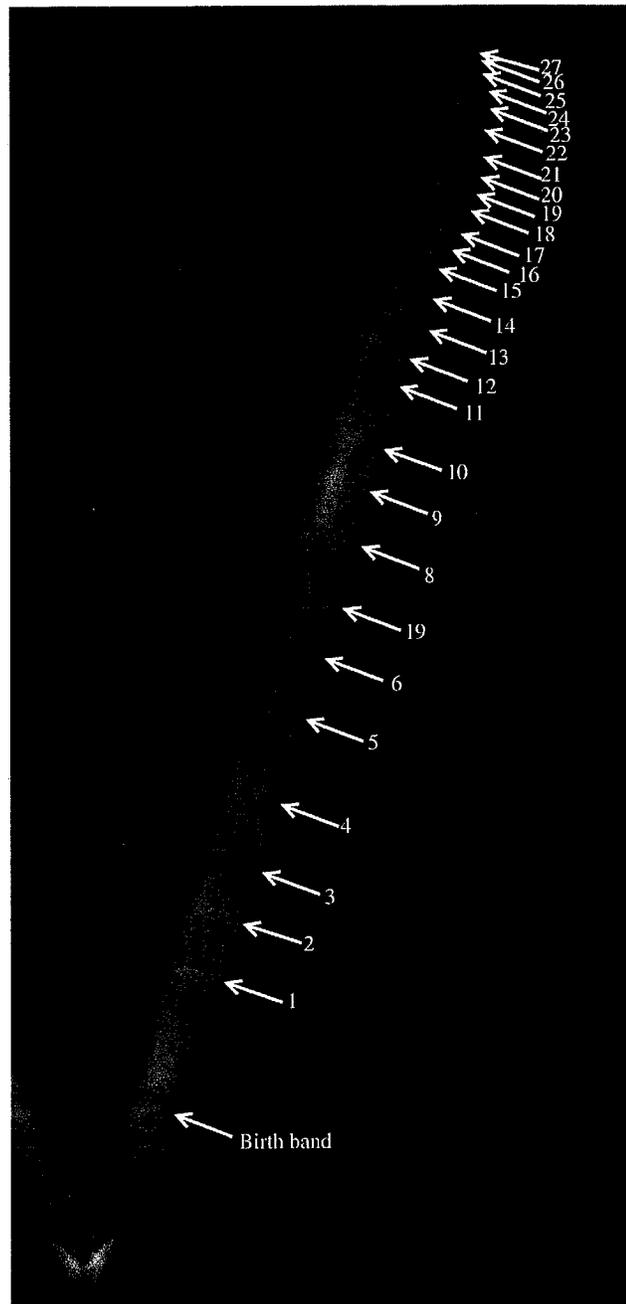


FIG. 3. Cross section of vertebra from the *Isurus oxyrinchus* with band pairs indicated by arrows.

at two band pairs per year based on oxytetracycline tagging (Wells *et al.*, 2013). In the Atlantic, bomb radiocarbon dating has shown that *I. oxyrinchus* probably deposits a single band pair per year, although the data did not preclude two band pairs being deposited in the first few years (Campana *et al.*, 2002; Ardizzone *et al.*, 2006). As this large *I. oxyrinchus* was caught in southern California waters, a band-pair deposition rate of two per year was assumed for the first 5 years switching to one per year thereafter; hence, the age was provisionally estimated to be 22 years.

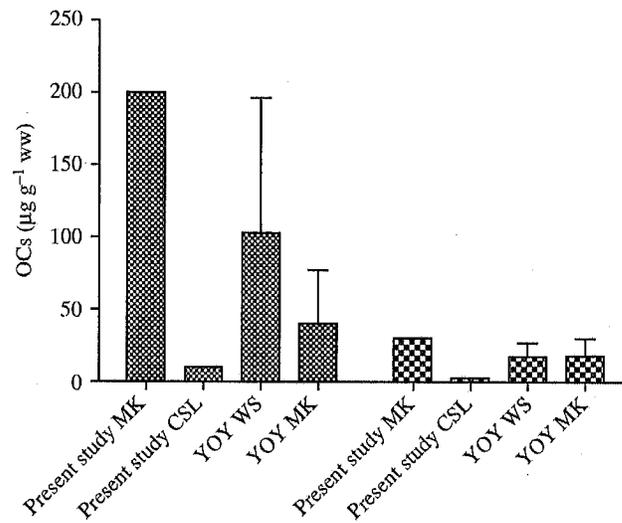


FIG. 4. Organochlorine (OC) concentrations (wet mass) for dichlorodiphenyltrichloroethanes (DDT) (■) and polychlorinated biphenyls (PCB) (▨) measured in the liver of the *Isurus oxyrinchus* (present study MK) and the blubber of the ingested *Zalophus californianus* (present study CSL) compared with levels previously measured in young-of-the-year (YOY) *Carcharodon carcharias* (WS) and *I. oxyrinchus* (MK; Lyons *et al.*, 2013).

The reproductive organs were removed from the animal, weighed and various lengths and widths were measured (Table I). The uteri were distended and flaccid and contained a small volume of a thick, yellowish fluid. Uterine widths were similar to those reported for post-partum females in other studies (Mollet *et al.*, 2000). The internal linings of the uteri were enfolded. The ovaries contained many small (*c.* 0.5 cm) atretic ova and appeared to be recently post-partum (L. Natanson, pers. comm.).

Dichlorodiphenyltrichloroethane (DDT) and its metabolites (dichlorodiphenyl dichloroethylene, DDE and dichlorodiphenyldichloroethane, DDD), along with 54 congeners of polychlorinated biphenyls (PCB), and chlorinated pesticides were measured in the liver (distal part of left lobe) of the shark and blubber (cervical region) from the CSL following methods of Lyons *et al.* (2013). Because of the high concentration of 4,4'-DDE initially measured in the hepatic tissue, the sample was diluted 1:40 for comparison with the standard curve. Two pairs of blank spikes, one pair of sample replicates, one certified reference material (CRM; Lake Trout Tissue 1947) and one blank were run in tandem with samples to ensure accuracy and precision. The per cent recovery of compounds was high (mean \pm s.d.) in the blank spikes ($96 \pm 17\%$), CRM ($102 \pm 13\%$) and recovery surrogates ($100 \pm 21\%$), and the relative s.d. among all replicates was low ($3 \pm 3\%$). Approximately 0.5 g of white muscle was analysed for mercury following the methods of Lyons *et al.* (2013).

DDTs were the most prominent class of organic contaminants measured in the liver, comprising 86% of the total, with the 4,4'-DDE being the most concentrated compound [200 and $250 \mu\text{g g}^{-1}$ wet (ww) and lipid (lw) mass, respectively]. Assuming homogenous concentrations of organic contaminants throughout the liver, *c.* 11.4 g of DDT compounds were estimated to be in the liver. PCBs (30 and $37 \mu\text{g g}^{-1}$ ww and lw,

respectively) comprised 13% of the total contaminant load. The contaminant concentrations in the CSL blubber were lower than those found in the liver when compared on a wet-mass basis (Fig. 4), but not on a lipid-mass basis. The ratio of [DDTs]:[PCBs] can be used to describe the relative proximity of an animal's food source to coastal California contamination point sources (e.g. the Palos Verdes Shelf Superfund site located 3 km offshore in Los Angeles County, CA) with higher ratios indicating closer proximity to the site. The DDT:PCB ratio was higher in the *I. oxyrinchus* (6.6) than it was in the sea lion (4.0). Mean \pm s.d. total mercury measured in the muscle tissue of the *I. oxyrinchus* was $20.8 \pm 0.8 \mu\text{g g}^{-1}$ wet mass, averaging across three replicates.

The trophic ecology of this large *I. oxyrinchus* was examined using stomach content analysis, SIA and contaminant signatures. These three methods consistently indicated that the *I. oxyrinchus* foraged at a high trophic level and that marine mammals were part of its diet. These results are not uncommon for large *I. oxyrinchus* in the NEP as previous examinations have documented the presence of pinnipeds in the stomachs of large female sharks in this region. In a separate series of studies conducted at the SWFSC, A. Preti and D. Kacev (unpubl. data) documented the presence of pinnipeds in the stomachs of five large (>296 cm) female *I. oxyrinchus*, and D. B. Holts and D. A. Ramon (unpubl. data) found the remains of a harbour seal *Phoca vitulina* and small odontocete in a large *I. oxyrinchus* caught near Santa Barbara Island, California. While it is difficult to determine whether the consumed CSL was the result of an attack or scavenging event, long streaking lesions on the CSL remains suggest an active attack. The rise in NEP pinniped populations probably provides a high quality food source for these large *I. oxyrinchus* (Carretta *et al.*, 2014). As smaller-sized *I. oxyrinchus* (<280 cm L_T) feed primarily on teleosts and squids (Preti *et al.*, 2012), it is possible that the role this species plays in local ecosystems may change with ontogeny as different food items are incorporated into the diet.

Mixing model estimates, by using prey data from the CCLME, rely on the assumption that this *I. oxyrinchus* was primarily a CCLME predator. It had higher $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values than other pelagic predators in the CCLME (Madigan *et al.*, 2012), but lower values than marine mammals and adult *C. carcharias* (Carlisle *et al.*, 2012). Based on tagging data of other large *I. oxyrinchus* (Kohler *et al.*, 2002; Block *et al.*, 2011), it is likely that this *I. oxyrinchus* made seasonal forays into oligotrophic waters as do adult *C. carcharias* (Carlisle *et al.*, 2012). The relative influence of prey type and foraging locations cannot be determined as prior movements are unknown. Offshore feeding in oligotrophic regions, however, would decrease $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of this *I. oxyrinchus*; thus, the SIA-based trophic position of this *I. oxyrinchus* is a conservative estimate (Fig. 2).

Southern California's unique DDT signature can be used to infer proximity of feeding to this coastal location. The higher DDT:PCB in this *I. oxyrinchus* than the consumed CSL and young-of-the-year *C. carcharias* (which acquire their signal maternally; Lyons *et al.*, 2013) was unexpected. Typically, CSLs and juvenile *C. carcharias* are nearshore and would thus be expected to have higher ratios than the generally more pelagic *I. oxyrinchus*. The ratio in the *I. oxyrinchus*, however, was lower than that found in white croaker *Genyonemus lineatus* (Ayres 1855) sampled directly from the Palos Verdes Shelf Superfund Site where ratios ranged from 15 to 22 (Gossett *et al.*, 1983). This strong coastal SCB DDT:PCB signature in the *I. oxyrinchus* could be explained by greater utilization of inshore waters than previously thought or by consumption of coastally associated prey that had ventured offshore.

Age and growth studies have generally been limited to smaller, younger specimens, which has made it difficult to estimate life span of the long-lived *I. oxyrinchus*. The large size of this *I. oxyrinchus* has provided a valuable data point that will give greater certainty to the upper end of growth curves, which is important for assessing the species' productivity and abundance and implementing appropriate management practices (Hoenig & Gruber, 1990). The exact age of this animal was uncertain due to the unresolved band-pair deposition rates across regions, ages and sexes for NEP *I. oxyrinchus*. Given the uncertainty in band-pair deposition rates for adults in the NEP, the specimen examined could be as young as 13.5 years if biannual band-pair deposition continues throughout life, or could be between the estimated ages of 13.5 and 22.0 years if an ontogenetic shift in banding periodicity occurs sometime after 5 years (Wells *et al.*, 2013). The size and estimated age range of this *I. oxyrinchus* fall near the top of the previously aged *I. oxyrinchus* in the Pacific Ocean as does the number of band pairs counted; however, some similarly sized sharks in the Atlantic have had as many as 32 vertebral band pairs, which were thought to be reflective of an annual deposition pattern based on bomb radiocarbon dating, suggesting a difference in growth rates and size at age between oceans (Cailliet & Bedford, 1983; Ardizzone *et al.*, 2006; Bishop *et al.*, 2006; Natanson *et al.*, 2006; Semba *et al.*, 2009; Doño *et al.*, 2015; H. H. Hsu, unpubl. data).

Previous reproductive studies of *I. oxyrinchus* have suggested that they reproduce every 2–3 years, with an estimated gestation of 12–25 months (Pratt & Casey, 1983; Mollet *et al.*, 2000, 2002; Joung & Hsu, 2005) followed by a rest period before the next pregnancy begins (Stevens, 2008). The lack of ovarian activity (*i.e.* ripe or developing ova 0.6–0.8 cm; Mollet *et al.*, 2000), presence of yellowish fluid in the distended uteri, spent ovaries with many atretic ova and the enfolded rather than smooth uterine lining suggest that this *I. oxyrinchus* had recently given birth and had not started her resting period at the time of capture. *Isurus oxyrinchus* are thought to pup from late winter to mid spring (Mollet *et al.*, 2000; Joung & Hsu, 2005). This post-partum female was caught in early June in the SCB, near the end of the purported pupping season. Since the SCB is a putative nursery, her presence in this area could have been for reproductive reasons in addition to feeding.

While the potential health effects of contaminants on sharks are not known, there are known concerns about human consumption of contaminants. The DDT and PCB concentrations present in the liver of the present specimen were nearly 100 and 250 times greater, respectively, than the no-consumption limit based on values developed by the US Environmental Protection Agency (Klasing *et al.*, 2009). Also, the high mercury loads measured in the muscle greatly surpass by *c.* 20-fold the US Food and Drug Administration's action level of $1.0 \mu\text{g g}^{-1}$ ww (USFDA, 2000), above which legal action will be taken to remove products from the market. Based on a 227 g (8 oz) serving size and using advisory tissue levels from Klasing *et al.* (2009), the levels measured in the *I. oxyrinchus* were *c.* 45 times greater than the no consumption level for women of child-bearing age and children and *c.* 15 times greater for women over 45 and men.

Valuable information was obtained from this animal on age and growth, reproduction, morphometrics and foraging ecology. This single specimen provided insights into the behaviour and ecology of large *I. oxyrinchus* in southern California ecosystems. Results from feeding ecology analysis suggest that both pinnipeds and coastal prey were components of the diet. High trophic level feeding coupled with a relatively old age contributed to high contaminant levels in this *I. oxyrinchus*. Although considered

rare, large *I. oxyrinchus* are caught in recreational fisheries in southern California, a fishery with considerable effort. Based on the present findings, large sharks like the specimen studied may spend protracted periods in coastal pelagic habitats (<20 km from the shore) where they may be vulnerable to capture in recreational fisheries. By understanding their habitat use and potential sources of mortality, especially for larger females, more reliable population assessments and appropriate management efforts can be achieved.

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CALIFORNIA FISH AND GAME COMMISSION
DECISION LIST FOR NON-REGULATORY ACTION THROUGH OCT 20, 2016
 Revised 11-18-2016

FGC - California Fish and Game Commission DFW - California Department of Fish and Wildlife WRC - Wildlife Resources Committee MRC - Marine Resources Committee

Date Received	Name of Petitioner	Subject of Request	Short Description	Staff Recommendation	FGC Decision
10/19/2016	Scott McBain, Humboldt Area Saltwater Anglers	Pacific halibut recreational quota	Requests support for increasing the Pacific halibut recreational quota.	<i>GRANT; FGC intends to identify a Commissioner to represent California's interest at International Pacific Halibut Commission (IPHC), and FGC directed staff to work with DFW staff in advance of IPHC meeting.</i>	RECEIPT: 10/19-20/2016 ACTION: Scheduled 12/7-8/2016
10/19/2016	Jenn Eckerle, Heal the Bay	Ballona wetlands	Requests detailed information about the status of the environmental impact report for the Ballona wetlands project.	<i>DENY; outside FGC's scope of authority. Requester should contact DFW or visit the Ballona Wetlands Restoration Project webpage.</i>	RECEIPT: 10/19-20/2016 ACTION: Scheduled 12/7-8/2017
10/19/2016	Tom Marking	Pacific halibut	Requests FGC or DFW write a letter requesting an explanation for the 2% allocation in the wake of accepting MSA (Magnuson-Stevens Fishery Conservation and Management Act) science.	<i>DENY; FGC intends to identify a Commissioner to represent California's interest at the International Pacific Halibut Commission (IPHC).</i>	RECEIPT: 10/19-20/2016 ACTION: Scheduled 12/7-8/2018
10/14/2016; 10/19/2016	Bill James; Kenyon Hensel (for Bill James)	ADA accommodation for commercial fishing	Requests an Americans with Disabilities Act accommodation for deeper nearshore fishing permits.	<i>Refer to DFW for evaluation and recommendation.</i>	RECEIPT: 10/19-20/2016 ACTION: Scheduled 12/7-8/2019

From: [Bill James](#)
To: [FGC](#); [Ashcraft, Susan@FGC](#)
Cc: [Larinto, Traci@Wildlife](#); [Yaremko, Marci@Wildlife](#)
Subject: 4. Deeper Nearshore Request by William James (Bill James)
Date: Monday, November 14, 2016 4:57:21 PM

Commissioner Sklar, Commissioner Silva: I request that the FGC authorize a second person to fish my Deeper Nearshore Permit as part of accommodation for my physical disability. I am a polio survivor, but now have increasing "post polio late effects". The nerve fibers are brittle and causing a loss of leg muscle function. Also I am on continued use of oxygen therapy. I have 3 kinds of sleep apnea, all related to my past severe case of polio as a child.

Also recently (August 13, 2016), after 2 days of nearshore fishing in Crescent City with Kenyon Hensel, my oxygen mask failed that night and I was taken unconscious to the hospital earlier the next day. I am currently rehabilitating and still want to fish commercially. I can fish one day but I cannot fish days in a row, hence my request. To make fishing profitable multiple days of fishing are necessary when the weather permits. I wish to fish one day and the next day rest while someone else fishes my permit for me. I will work with the Commission and the Department of Fish and Wildlife and answer any questions you have, Sincerely, William James (Bill James)



Tracking Number: (2016-005)

To request a change to regulations under the authority of the California Fish and Game Commission (Commission), you are required to submit this completed form to: California Fish and Game Commission, 1416 Ninth Street, Suite 1320, Sacramento, CA 95814 or via email to FGC@fgc.ca.gov. Note: This form is not intended for listing petitions for threatened or endangered species (see Section 670.1 of Title 14).

Incomplete forms will not be accepted. A petition is incomplete if it is not submitted on this form or fails to contain necessary information in each of the required categories listed on this form (Section I). A petition will be rejected if it does not pertain to issues under the Commission's authority. A petition may be denied if any petition requesting a functionally equivalent regulation change was considered within the previous 12 months and no information or data is being submitted beyond what was previously submitted. If you need help with this form, please contact Commission staff at (916) 653-4899 or FGC@fgc.ca.gov.

SECTION I: Required Information.

Please be succinct. Responses for Section I should not exceed five pages

1. Person or organization requesting the change (Required)

Name of primary contact person: John Demers

Address:

Telephone number:

Email address:

2. Rulemaking Authority (Required) - Reference to the statutory or constitutional authority of the Commission to take the action requested: The section of the California Code of Regulations that governs this activity (14 CCR 122 (o)) is under the authority of the Fish and Game Commission – Department of Fish and Game

3. Overview (Required) - Summarize the proposed changes to regulations: The Port of Hueneme requests that the entirety of the safety fairway for the Port, as shown on NOAA chart 18724, be placed off limits for the placement of lobster traps and similar devices.

4. Rationale (Required) - Describe the problem and the reason for the proposed change: The Port of Hueneme (Port) is formally requesting the California Fish and Game Commission (Commission) to consider and approve regulation changes that will significantly improve the safety of vessel operations in the vicinity of the Port. The justification for this request is that the placement of commercial fishing equipment within operating areas at the Port currently poses a hazard to safe navigation. The Port has been a popular location for the placement of fishing equipment, primarily lobster traps (pots) but also other various items. These items typically contain large amounts of line that attach the trap itself to a float. If this line becomes entangled in the propulsion or steering equipment of a vessel, the vessel could lose the ability to safely navigate, and risks a collision, allision or grounding. The entanglement could cause significant damage which would require lengthy and costly repairs. Also, the Port has a somewhat difficult approach and a narrow entrance channel. As a part of our routine operations, we receive ocean going vessels up to 230 meters LoA. As these vessels enter or depart, our Harbor Safety Plan requires that they receive the assistance of two tugs to ensure safe transit. If one of these tugs should experience a propulsion or steering casualty from entanglement while engaged in



maneuvering a vessel into or out of the harbor, a significant safety hazard would occur since that tug would be unable to continue to provide vessel assistance. The presence of these fishing devices in the vicinity of the Port greatly increases the chance that a tug will experience a mechanical casualty, and creates the possibility of a collision, allision, or grounding, with the risk of significant damage to the vessel and surrounding structures and the possibility of environmental damage from a fuel or oil leak from the damaged vessel. To date, the Port has tried to manage the situation by working with the local fishing community. Where that has not been fully successful, the Port has taken it upon itself to move traps into safer areas. This method has proven inadequate as the traps soon return. We have spoken with local Fish and Wildlife representatives, as well as the U.S. Coast Guard, who have both advised us that they are unable to provide assistance as there is not currently an enforcement mechanism. This situation has necessitated our request for regulatory changes.

SECTION II: Optional Information

5. **Date of Petition: April 8, 2016**
6. **Category of Proposed Change**
 - Sport Fishing
 - Commercial Fishing
 - Hunting
 - Other, please specify: [Click here to enter text.](#)
7. **The proposal is to:** *(To determine section number(s), see current year regulation booklet or <https://govt.westlaw.com/calregs>)*
 - Amend Title 14 Section(s):122 (o) (2), by adding a new item (D)
 - Add New Title 14 Section(s): [Click here to enter text.](#)
 - Repeal Title 14 Section(s): [Click here to enter text.](#)
8. **If the proposal is related to a previously submitted petition that was rejected, specify the tracking number of the previously submitted petition** [Click here to enter text.](#)
Or Not applicable.
9. **Effective date:** If applicable, identify the desired effective date of the regulation.
If the proposed change requires immediate implementation, explain the nature of the emergency: October 1, 2016
10. **Supporting documentation:** Identify and attach to the petition any information supporting the proposal including data, reports and other documents: [Click here to enter text.](#)
11. **Economic or Fiscal Impacts:** Identify any known impacts of the proposed regulation change on revenues to the California Department of Fish and Wildlife, individuals, businesses, jobs, other state agencies, local agencies, schools, or housing: No known impacts, as fishing could occur nearby and replace any losses from not fishing within the safety fairway.
12. **Forms:** If applicable, list any forms to be created, amended or repealed:
[Click here to enter text.](#)



SECTION 3: FGC Staff Only

Date received: April 8, 2016 8:46 AM

FGC staff action:

- Accept - complete
- Reject - incomplete
- Reject - outside scope of FGC authority

Tracking Number

Date petitioner was notified of receipt of petition and pending action: May 24, 2016

Meeting date for FGC consideration: June 22-23, 2016

FGC action:

- Denied by FGC
- Denied - same as petition _____
Tracking Number
- Granted for consideration of regulation change

From: [Martin%20Strain](#)
To: [Ashcraft, Susan@FGC](#)
Cc: [Ramey, Kirsten@Wildlife](#); [Lovell, Randy@Wildlife](#)
Subject: Point Reyes Oyster Company"s effort to add algal species to its growing area permits.
Date: Wednesday, September 28, 2016 9:56:23 AM

Hello Ms. Ashcraft,
Kirsten Ramey informed me that the cost to conduct a CEQA review to add algal species that grow naturally on our shellfish culture gear would be in the \$50,000.00 range. We would be unable to recoup that kind of investment during the tenure of our leases. With that in mind I am withdrawing our request to amend our leases M430-13, M430-14, and M430-17 in Tomales Bay for the purposes of gleaning and selling algal species. Thank you for all of your help.
Sincerely,
Martin Strain, President, Point Reyes Oyster Company, Inc.