



Seafood menus reflect long-term ocean changes

Peer-reviewed letter

Global fisheries declines have alerted ecologists that long-term ecosystem assessments require diverse information sources (Jackson *et al.* 2001; Lotze and Worm 2009). Non-traditional sources of information on past marine ecosystems have included photographs (McClenachan 2009a), newspapers (McClenachan 2009b; Van Houtan *et al.* 2012), artwork (Guidetti and Micheli 2011), and living memory (Sáenz-Arroyo *et al.* 2005; Kittinger *et al.* 2013). To date, this information has been taken primarily from historical harvest records, but a secondary and largely untapped wealth of data exists on consumption. Archaeologists have long analyzed preserved midden deposits to understand resource use and its ecological impacts (eg Reitz 2004). Restaurant menus may provide a recent analog to middens, given that they document seafood consumption over time and potentially the availability and value of different species in the past. Menus have been used to evaluate historical changes in seafood popularity (Jones 2008; Hall and Camhi 2012), but published studies using menus to track wild population abundance are limited. Hawaii is perhaps an ideal location to use menus to analyze historical changes in the marine environment because its remote location meant most locally consumed seafood was locally sourced (Geslani *et al.* 2012).

We analyzed 376 menus from 154 different restaurants in Hawaii (Figure 1a), dated from 1928 to 1974, to supplement official fishery landing records and to infer changes in the availability of marine resources. The menus represent a range of eateries from local businesses to larger restaurants serving tourists (we excluded 60 cruise-ship menus because their pantries were not locally sourced).

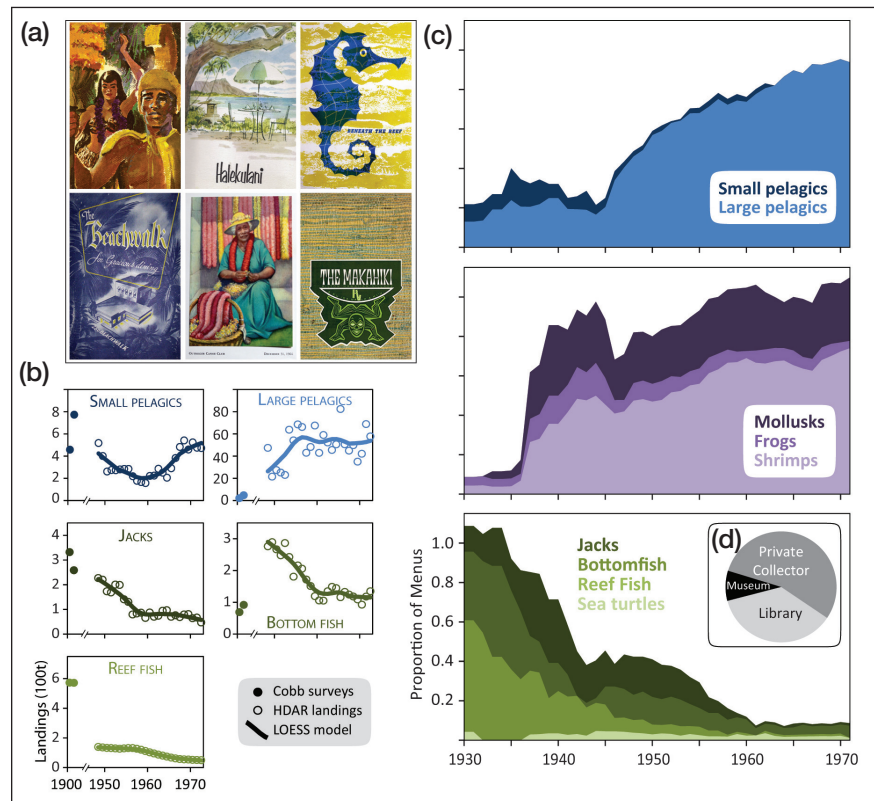


Figure 1. Historical marine resource insights from restaurant menus. (a) Menu covers from six Honolulu restaurants circa 1960 (courtesy M Payne/Arkiva Tropika). (b) Commercial landings for five fish guilds in Hawaii from early US Government surveys (Cobb 1905) and the Hawaii Department of Aquatic Resources (HDAR); note the break in time on the x axis. LOESS = locally weighted regression. (c) Menu occurrence of fishery items follows the rise and fall of local fisheries: wild-caught offshore fish species (top panel), imported and aquaculture species (middle panel), and wild-caught inshore species (bottom panel). (d) More than half of the restaurant menus used in this study came from private archives.

Importantly, these menus bridge a critical 45-year gap in early 20th-century fishery records. We compared landings from early market surveys (Cobb 1905) and later government fishery statistics for five historically important fish guilds (Figure 1b) against the presence of these guilds on restaurant menus (WebTable 1), calculating their proportion of occurrence in a 9-year moving window (Figure 1c).

The menus capture many of the marked shifts reflected in fishery landings, and perhaps additional changes in market supply and in public preference. Reef fish, jacks, and bottomfish were common on menus before 1940, but by Hawaii's statehood in 1959 these items appeared collectively on less than 10% of the menus sampled. This period marked a rapid growth in pelagic fisheries

(Schug 2001) and concurrent declines in nearshore fishery stocks (Figure 1b). While nearshore resources sharply declined, restaurants shifted to serving large pelagic fish (Figure 1c). By 1970, 95% of our menus contained large pelagics. For nearshore guilds, changes in menu occurrence may reflect market availability (and by proxy wild abundance) rather than shifts in consumer preferences (Geslani *et al.* 2012). Not all local fishery dynamics are reflected in menus. Mollusks and shrimps were mostly imported from the mainland US, and frogs were obtained from local aquaculture farms. Sea turtles were harvested in a commercial fishery in Hawaii; turtle meat, however, was sold primarily at local fish markets, not in restaurants (Van Houtan and Kittinger in review). Although we did not evalu-

ate listed prices on menus, future attention here may reveal how consumer preference influenced these changes. Private collectors supplied most of our menus (Figure 1d), suggesting that traditional research archives in some cases may harbor only a fraction of such information.

Restaurant menus represent an intriguing data source with the potential to fill existing knowledge gaps and measure long-term ecosystem changes. Nevertheless, we caution that menus should be used selectively and in concert with relevant socioeconomic information on fishery operation and culture. Market dynamics, resource abundance, availability, and consumer preference can all influence menu trends. However, fish occurrence on menus may be a useful proxy of population changes when species are locally harvested and restaurants are the major market. In our research on Hawaiian fisheries, this was the case for small pelagics, large pelagics, bottomfish, jacks, and reef fish. Alternatively, local wild-caught species may primarily supply a non-restaurant market (as with sea turtles), or may come from local aquaculture (as with frogs) or be imported (as with mollusks and shrimps). These latter instances may still present important information, such as the market forces supporting wildlife harvests (Van Houtan and Kittinger in review). Our research also revealed that a wealth of restaurant menus

exist in private collections in addition to traditional research archives (Jones 2008). When compiled and interpreted in the appropriate socioeconomic context, menus have great potential as a window to the past.

Kyle S Van Houtan^{1,2*},
Loren McClenachan³, and
John N Kittinger⁴

¹NOAA Fisheries, Pacific Islands Fisheries Science Center, Honolulu, HI *(kyle.vanhoutan@gmail.com);

²Nicholas School of the Environment and Earth Sciences, Duke University, Durham, NC; ³Environmental Studies Program, Colby College, Waterville, ME; ⁴Center for Ocean Solutions, Stanford University, Monterey, CA

■ Acknowledgements

This is the fourth paper from the NOAA Pacific Sea Turtle Historical Ecology Working Group. A Presidential Early Career Award for Scientists and Engineers to KSVH supported this project.

Cobb JN. 1905. The commercial fisheries. In: Jordan DS and Evermann BW (Eds). The aquatic resources of the Hawaiian Islands. Washington, DC: Government Printing Office.

Geslani C, Loke M, Takenaka B, and Leung P. 2012. Hawaii's seafood consumption and its supply sources. *SOEST Publ JIMAR Contrib* 12: 1–26.

Guidetti P and Micheli F. 2011. Ancient art serving marine conservation. *Front Ecol Environ* 9: 374–75.

Hall C and Camhi M. 2012. A four-century retrospective of marine fauna and fisheries around New York City. New York, NY: Wildlife Conservation Society.

Jackson JBC, Kirby MX, Berger WH, et al.

2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629–37.

Jones GA. 2008. Quite the choicest protein dish: the costs of consuming seafood in American restaurants, 1850–2006. In: Starkey DJ, Holm P, and Barnard M (Eds). Oceans past: management insights from the history of marine animal populations. London, UK: Earthscan.

Kittinger JN, Van Houtan KS, McClenachan L, and Lawrence AL. 2013. Using historical data to assess the biogeography of population recovery. *Ecography* 36: 868–72.

Lotze HK and Worm B. 2009. Historical baselines for large marine animals. *Trends Ecol Evol* 24: 254–62.

McClenachan L. 2009a. Documenting loss of large trophy fish from the Florida Keys with historical photographs. *Conserv Biol* 23: 636–43.

McClenachan L. 2009b. Historical declines of goliath grouper populations in South Florida, USA. *Endang Species Res* 7: 175–81.

Reitz EJ. 2004. Fishing down the food web: a case study from St Augustine, Florida, USA. *Am Antiquity* 69: 63–83.

Sáenz-Arroyo A, Roberts C, Torre J, et al. 2005. Rapidly shifting environmental baselines among fishers of the Gulf of California. *P R Soc B* 272: 1957–62.

Schug DM. 2001. Hawaii's commercial fishing industry: 1820–1945. *Hawaiian J Hist* 35: 15–34.

Van Houtan KS and Kittinger JN. Using historical harvest data to assess long-term drivers of population change. *P R Soc B*. In review.

Van Houtan KS, Kittinger JN, Lawrence AL, et al. 2012. Hawksbill sea turtles in the northwestern Hawaiian Islands. *Chel Conserv Biol* 11: 117–21.

doi:10.1890/13.WB.015

TAKE THIS JOURNAL TO YOUR LIBRARIAN, PLEASE

Are you enjoying this issue of *Frontiers*?

If your library had a subscription, colleagues and students could enjoy it too.

Please consider recommending *Frontiers in Ecology and the Environment* to your library.

Clip or copy the form below.

Thank you for your support.

Library Recommendation Form

To Acquisition Librarian, Serials

From _____

Dept _____

Signature _____ Date _____

I recommend the library subscribe to: *Frontiers in Ecology and the Environment* (ISSN 1540-9295)

To request a free sample issue of *Frontiers in Ecology and the Environment*, email Eric Gordon at eric@esa.org.

Order *Frontiers* by contacting ESA Headquarters at (202) 833-8773, online at www.esa.org, or through your subscription agent.

