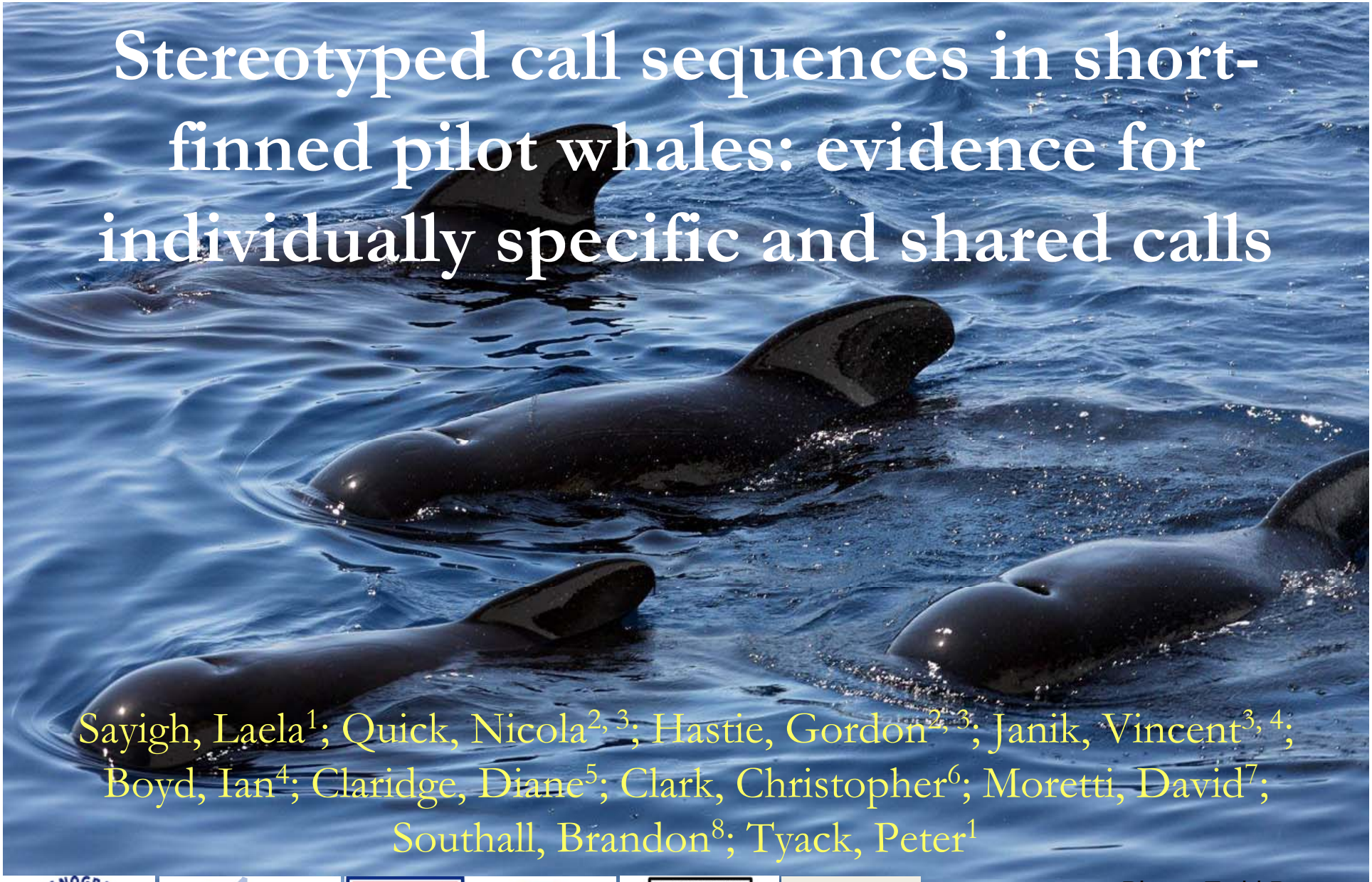
Stereotyped call sequences in short-finned pilot whales: evidence for individually specific and shared calls



Sayigh, Laela[1]; Quick, Nicola[2, 3]; Hastie, Gordon[2, 3]; Janik, Vincent[3, 4]; Boyd, Ian[4]; Claridge, Diane[5]; Clark, Christopher[6]; Moretti, David[7]; Southall, Brandon[8]; Tyack, Peter[1]

Photo: Todd Pusser

Behavioral Response Study 2007-08 (Tongue of the Ocean, Bahamas)

- Goal: to document responses of beaked whales and other odontocetes to controlled exposures of mid-frequency sonar and killer whale sounds
- Animals were tagged with non-invasive DTAGs (Johnson and Tyack 2003) to measure acoustic and movement responses to playbacks

Behavioral Response Study 2007-08
Other SMM Presentations

- **Allen**, Ann N., Ari Daniel Shapiro, Andrew Solow, Peter L. Tyack, Ian Boyd, Diane Claridge, Christopher Clark, David Moretti, and Brandon L. Southall "*Analysis of a Blainville's beaked whale movement response to playback of orca calls*"
  [POSTER: 1730-1900 on 13 and 15 October SUNDOWNER II sessions]

- **Southall**, Brandon L., Peter L. Tyack, David Moretti, Christopher Clark, Diane Claridge, and Ian Boyd. "*Behavioral responses of beaked whales and other cetaceans to controlled exposures of simulated sonar and other sounds*"
  [**PRESENTATION TIME: 1700 on THURSDAY 15 Oct in Room 200C**]

- **DeRuiter**, Stacy L, Ian Boyd, Diane Claridge, Chistopher Clark, David Moretti, Brandon Southall, and Peter L. Tyack. "*False killer whales mimic MFA sonar*"
  [**PRESENTATION TIME: 0845 on FRIDAY 16 Oct in Room 200C**]

- **Quick**, Nicola; Sayigh, Laela; Hastie, Gordon; Janik, Vincent; Claridge, Diane; Clark, Christopher; Moretti, David; Southall, Brandon; Tyack, Peter and Boyd, Ian. "*Vocal behavior of short-finned pilot whales pre, during and post exposure to playbacks of mid frequency active sonar and killer whale calls*"
  [**PRESENTATION TIME: 0900 on FRIDAY 16 Oct in Room 200C**]

Behavioral Response Study (BRS)

- In order to assess possible vocal responses of pilot whales to playbacks, it was first necessary to characterize the pilot whale vocal repertoire
  - Few studies have attempted this
    - For long-finned pilot whales, Taruski (1979) and Weilgart and Whitehead (1990) grouped whistle-like calls into 7 broad categories; Nemiroff and Whitehead (in press) described structural characteristics of calls
    - No studies of short-finned pilot whales

Data set

Four short-finned pilot whales, *Globicephala macrorhynchus*, were tagged with DTAGs for a total of 30 hours

Photo: Gianni Pavan

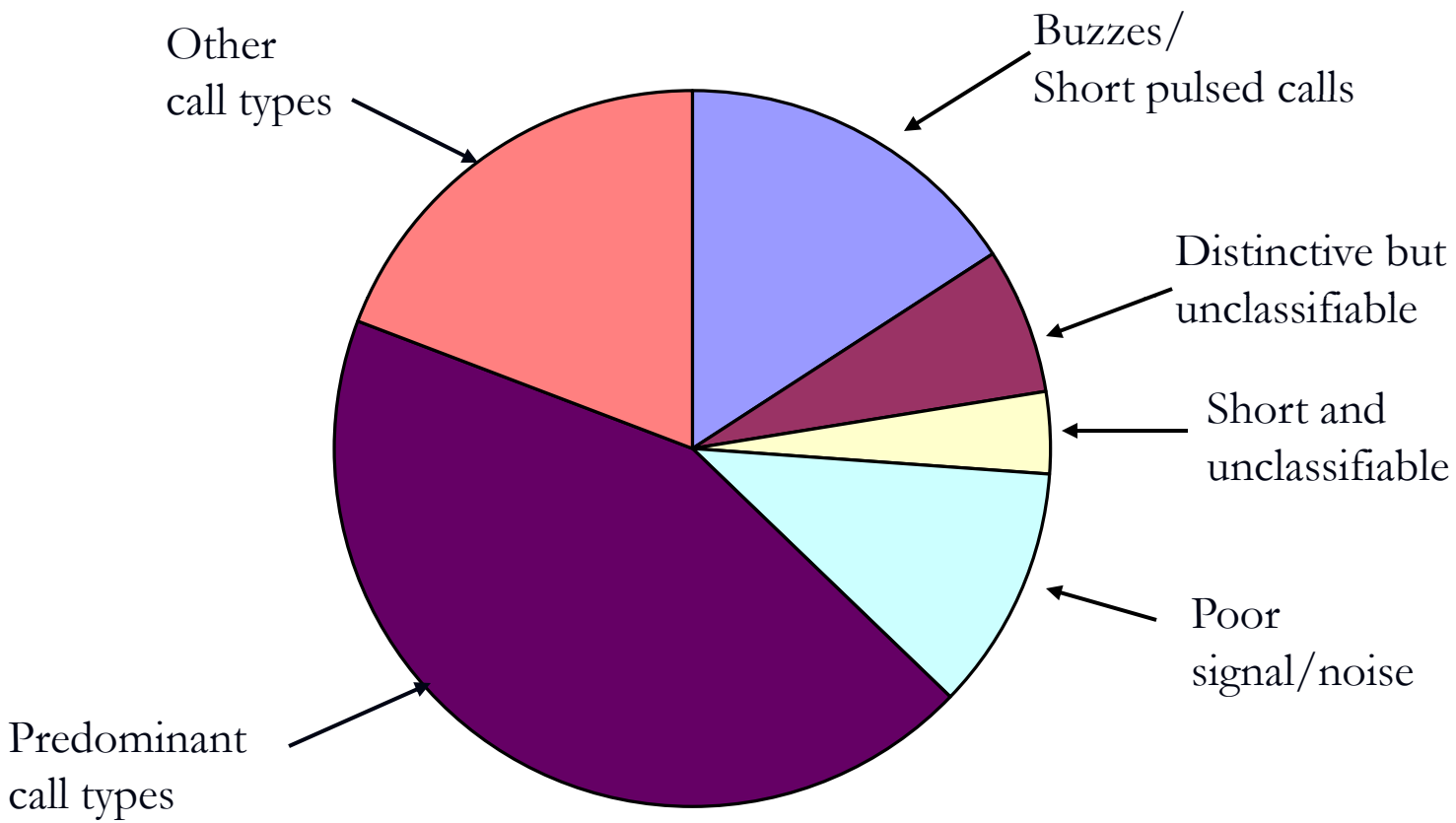
Methods for call categorization

- All audible sounds were excised from DTAG records (n = 3,202 files, some containing multiple calls) and spectrograms were made of all files
- Spectrograms were independently categorized into call types by three observers
  - Call type was defined as any call that occurred at least twice
- In cases where original assessments were not in agreement, consensus was reached

Results of call categorization

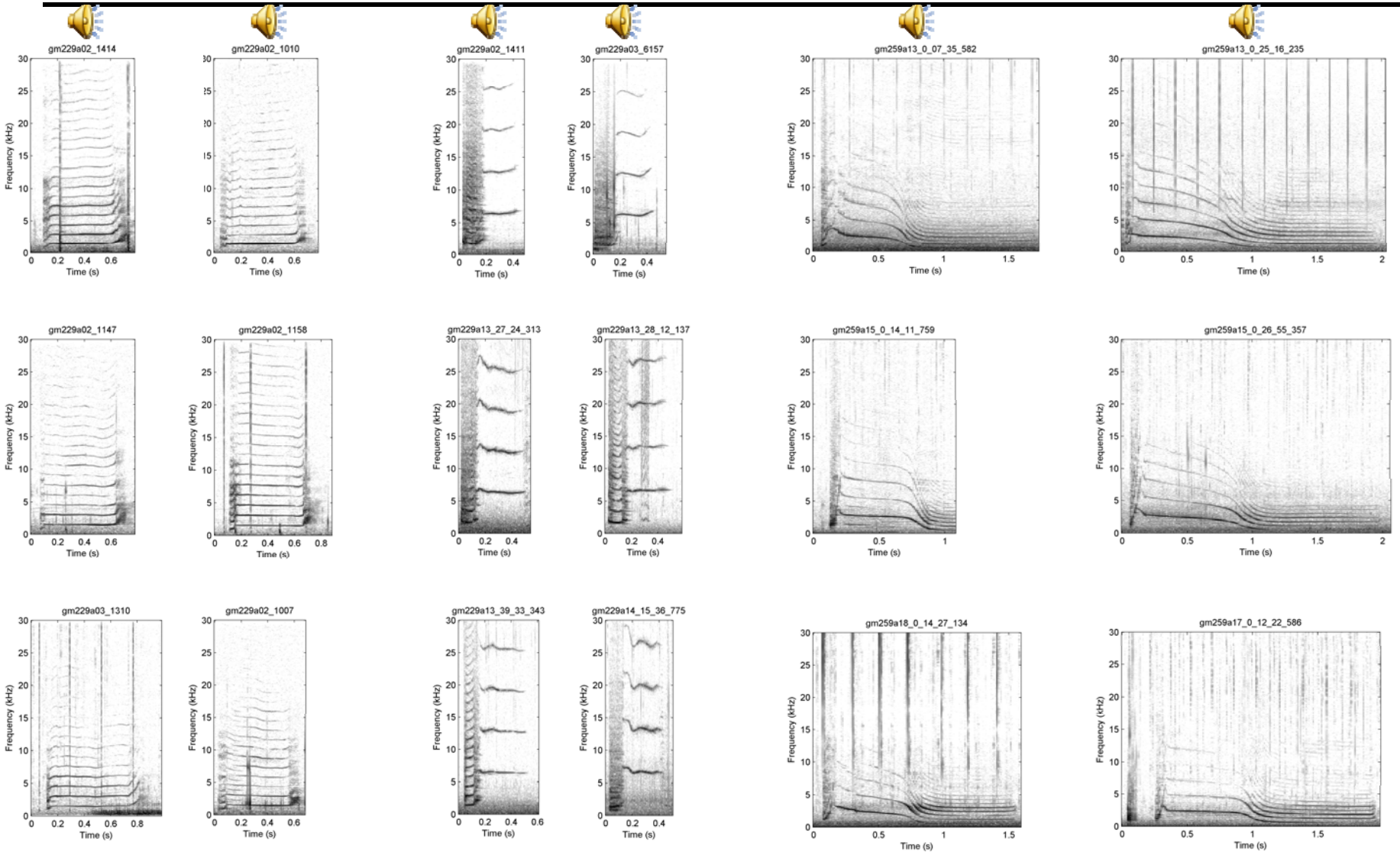
- Of 2,769 calls categorized so far, 1,727 (54%) were placed into 169 call types
  - Remainder: poor S/N, distinctive but unclassifiable, short calls, buzzes
- Of the 169 call types, 50 contained a minimum of 10 calls (mean = 25), and comprised 1,232 (71%) of the categorized calls
  - referred to as predominant call types (PCT)
- PCT's accounted for 50% of all calls with sufficient signal/noise for categorization

Call categorization



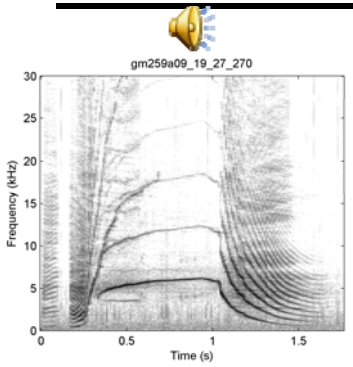
Examples of predominant call types

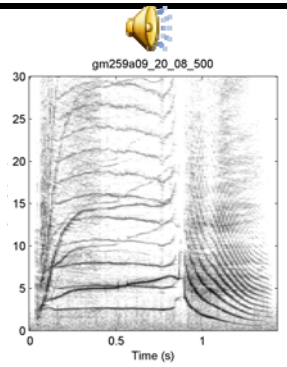
1T KK rr2

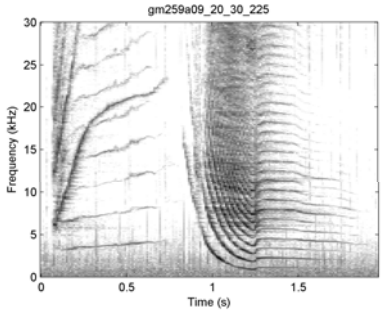


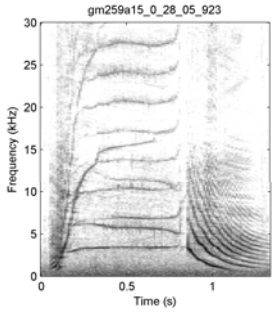
Examples of predominant call types

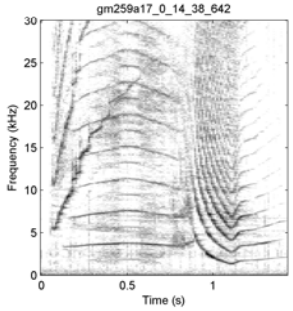
EE*

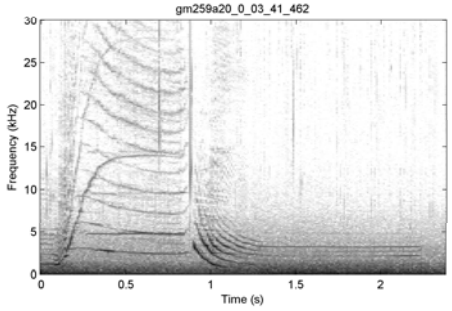












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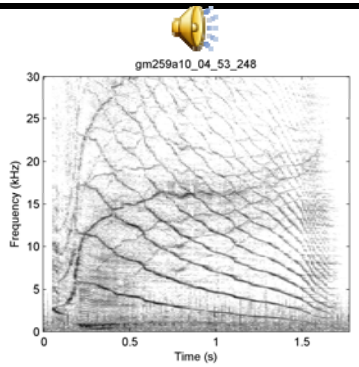
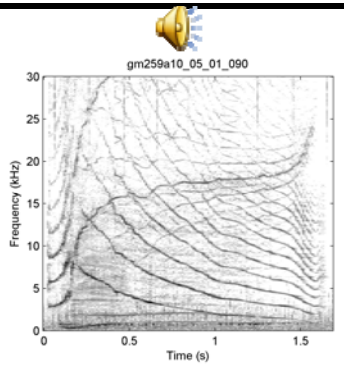
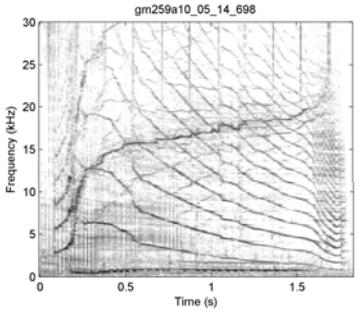
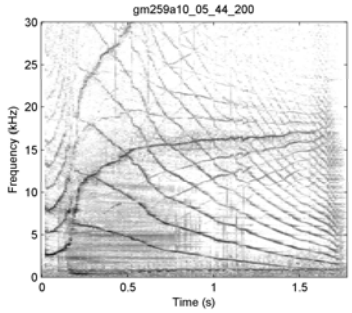
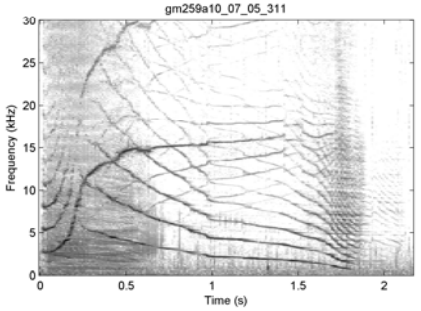
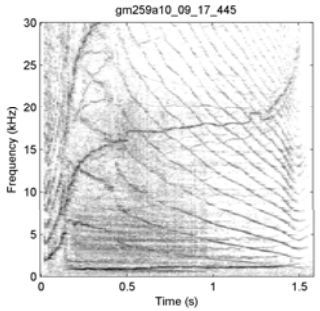










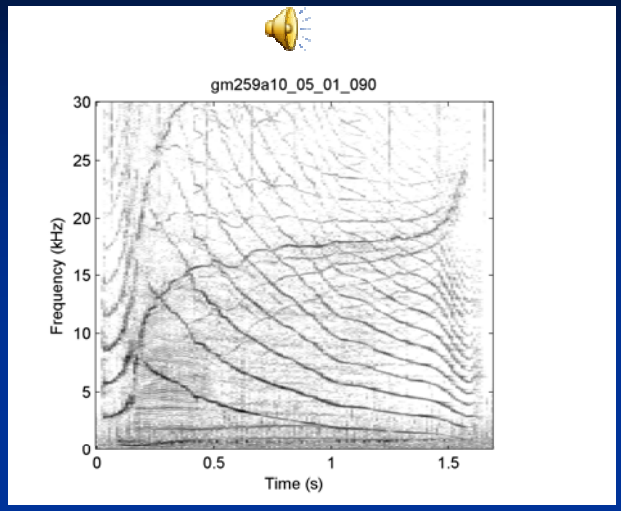


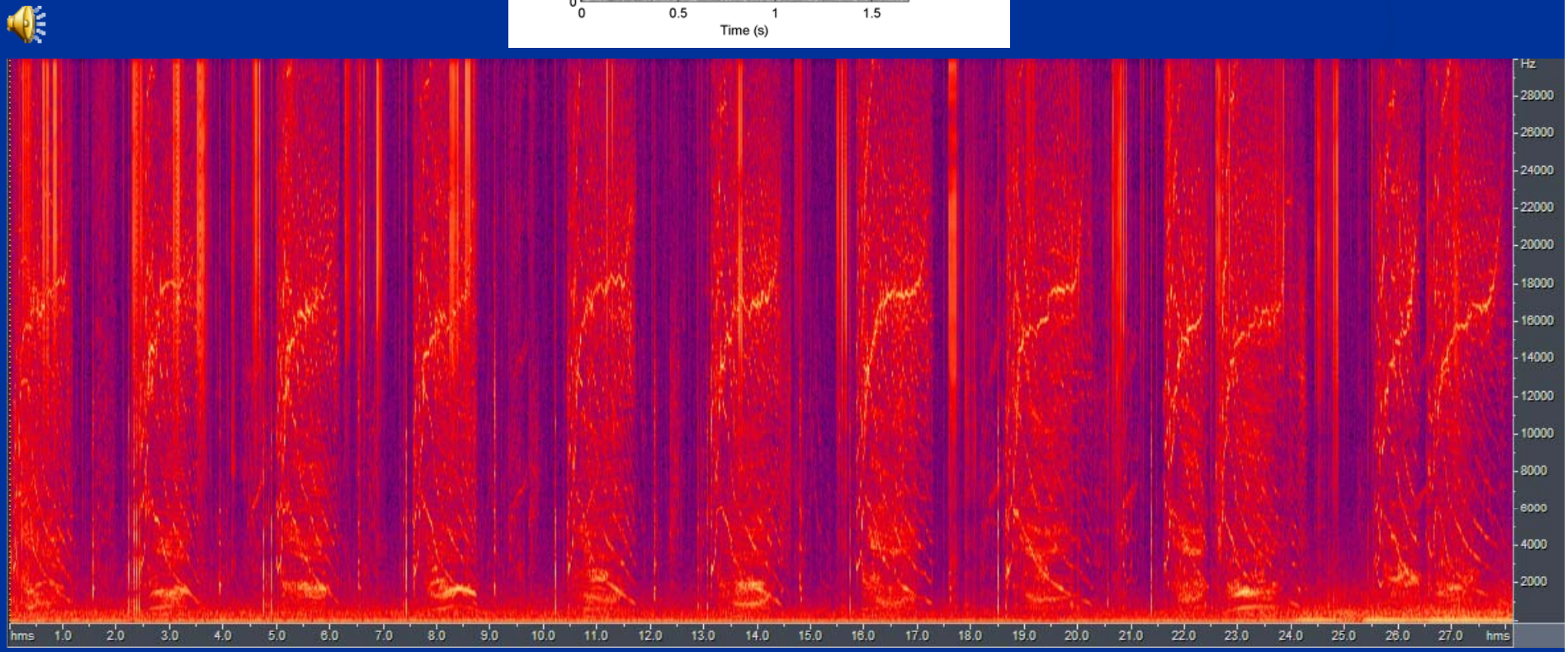
*note high frequencies (maximum reported frequencies are 10-14 kHz)

Predominant call types (PCT) tended to occur in close sequences

- Of 1,232 PCT's, significantly more (974 or 79%) occurred within 30 seconds of another PCT of the same type than over greater time periods (Wilcoxon signed ranks test, $p<0.00001$)

PCT sequence





“Unshared” and “shared” calls

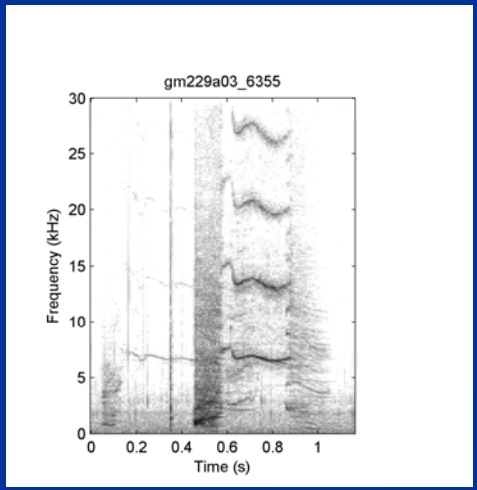
- 40 (80%) of the 50 predominant call types occurred on only one tag
  - termed "unshared" calls
- Nine call types occurred on two tags and one occurred on three tags
  - termed "shared" calls

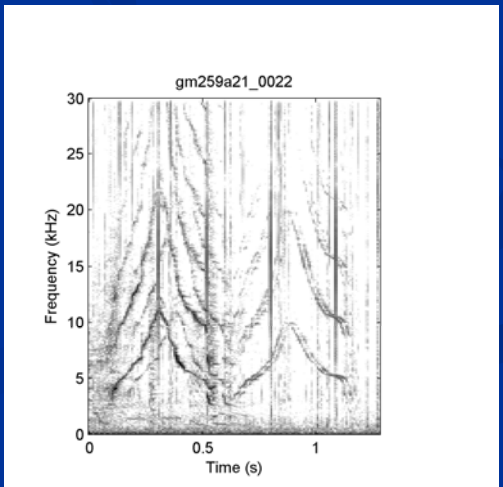
"Unshared" calls were more likely to occur in dense sequences

- "Unshared" calls were significantly more likely to occur within 30 seconds of another call of the same type than were "shared" calls (chi square, $p<0.001$)
- Amplitudes (and in some cases angles of arrival) were mostly consistent with calls in a given sequence being produced by the same individual

However, "unshared" calls were more likely to occur in matching interactions

- Adjacent or overlapping calls of the same type but different amplitudes were significantly more likely to occur among "unshared" calls than among "shared" calls (chi square test, $p<0.01$)
- Suggest matching interactions among nearby whales





"Unshared" = individually distinctive calls?

- Overall, the characteristics of "unshared" calls are very similar to those of bottlenose dolphin signature whistles, which are often produced in dense sequences and are occasionally used in matching interactions with other dolphins (Tyack, 1986, Janik 2000)
- Caldwell and Caldwell (1969) reported individually distinctive calls in several captive short-finned pilot whales

"Shared" = group-specific calls?

- "Shared" calls found on multiple tags appear similar to the group-specific calls of killer whales
- Pilot whale social structure resembles that of killer whales
- Our data suggest there may also be similarities in the acoustic behavior of pilot and killer whales

Future work

- Measure angles of arrival to determine if the focal whale produces "unshared" call sequences
- Measure call amplitudes to determine if "shared" calls come from more than one whale
- Examine behavioral/dive related correlates of "shared" and "unshared" calls
- Use automated call classification technique (Deecke and Janik 2006)
- Increase sample size and compare different populations

Summary and conclusions

- Pilot whales produce stereotyped calls
  - In 30 hours of DTAG recordings, 50 predominant call types (PCT's) comprised 50% of calls with sufficient S/N for categorization
  - "Unshared" calls were recorded on only one tag
    - highly likely to occur in dense sequences, which are likely to be produced by a single individual
    - occasionally exchanged in matching interactions with nearby whales
  - "Shared" calls were recorded on more than one tag
    - Also occurred in sequences but not as frequently as "unshared" calls
- Data suggest that pilot whales likely produce a combination of both shared and individually distinctive call types

Behavioral Response Study 2007-08

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Thanks also to Luke Rendell for Matlab code

Photo: Todd Pusser

** BRS test coordinators (Spikes: 07; D'Amico: 08)*

DoD EPA DOE SERDP Strategic Environmental Research and Development Program

DEPARTMENT OF THE NAVY ONR Science & Technology

NOAA

Chief of Naval Operations Environmental Readiness Division

INTEGRATED WARFARE ASW UNDERSEA SYSTEMS TRANSFORMING ASW

OGP International Association of Oil & Gas Producers